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The Currency Problem and Its Solution—
A Business Man's View of the Situation. ABRAHAM MILLS. 187

Taxation in the United States—
The Extent of Its Burden Upon Production. EDWARD ATKINSON. 194

Contemporary English Architects and their Work—
Valuable Object Lessons for American Architects. H. HEATHCOTE STATHAM. 203

The Prevailing Scarcity of Skilled Mechanics—
Wonderful Expansion of the Mechanical Industries. A. E. OUTERBRIDGE, Jr. 227

The Distribution of Power in Collieries—
Electricity and a Single Generator Strongly Advocated. LLEWELYN B. ATKINSON. 236

Transatlantic Steamships of 1856 to 1880—
Advent of the Screw Propeller and Compound Engine. SAMUEL WARD STANTON. 245

Will a Bridge Across the Hudson River Pay?—
A New York Problem of National Importance. GUSTAV LINDENTHAL. 261

The Limits of Electric Power Transmission—
From the Standpoint of Commercial Practicability. ALTON D. ADAMS. 269

The Colorado Springs Water-Works—
A Typical Mountain Lake Supply System. ARTHUR LAKES. 273

The Massachusetts Railroad Commission—
A Successful System of State Supervision. WILLIAM A. CRAFTS. 286

Obituary—Franklin Leonard Pope—295.

Review of the Industrial Press—

With an Index to all the leading articles published currently in the technical journals of the United States and Great Britain.

Architecture and Building, . 302
Civil Engineering, ... 310
Domestic Engineering, . . . 318
Electricity, ... 323
Industrial Sociology, . . . 332
Marine Engineering, . . . 341
Mechanical Engineering, . 346
Mining and Metallurgy, . . 354
Municipal Engineering, . . 364
Railroading, ... 371
Scientific Miscellany, . . 380
Books of the Month, . . . 388
Improved Machinery, . . 391.

FOR INTRODUCTION TO AUTHORS, SEE PAGE 5.

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Franklin Leonard Pope

THE

ENGINEERING MAGAZINE

VOL. X. NOVEMBER, 1895. NO. 2.

THE CURRENCY PROBLEM AND ITS SOLUTION.

By Abraham Mills.

THE columns of the New York *Evening Post* have lately been the medium of a very intelligent discussion of the problem of relieving the United States government of the burden of maintaining a gold reserve as the basis of our currency system, and of securing and maintaining an automatic gold reserve. The clearest and most concise exposition of the natural laws of trade governing exports and imports of gold was embodied in the following communication, which explains itself fully:

To the Editor of the Evening Post:

SIR,—Permit me to supply your correspondent G. S. C. with the specific information he requests as to what natural law of trade exists to regulate the international movement of gold in the absence of governmental management. He answers himself when he asks what "natural" law. He concedes there is such a law, and where such exists there is no necessity for man's interference. Like the law of gravity, it always works, and quickly resents any interference. And this is exactly why all the great commercial nations of the world cling so persistently to the gold standard: not only because it is the soundest measure of value, but also because it is the unit recognized as standard among themselves.

Therefore, when from any cause there is great business activity and advancing prices in one country, exports to that country are large and imports from it fall off, and both on account of the high prices there ruling. The foreign investor also sells its securities, tempted by the inflated values which generally prevail during "boom" times. The balance of trade, therefore, rapidly runs against that country, and settlements by gold shipments follow. When the government is not in the banking business, the banks must furnish this gold, and every dollar taken from their vaults diminishes their reserves, and contracts, as four to one, their ability to discount and to accommodate anxious borrowers. Loans are called in, money becomes dearer, prices of securities and merchandise decline, imports diminish, and exports increase, and

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naturally that of gold stops. Like every phenomenon of action and reaction, the latter goes too far. Prices fall so low that they tempt the foreigner, and he sends back gold to invest, because there is nothing else he can send without loss. The banks' reserves are thus quickly replenished, the crisis is over, and business resumes its normal condition.

In this manner all trade is safely regulated in countries using an international standard of value, and commercial crises are rarely known. I do not refer to banking or stock-exchange panics. While they are rare, they do happen in gold-standard countries. But it is wonderful to note how short lived they are and how little damage they do, because there is so quick and beneficent an interchange of standard money. Meantime prices of merchandise are little affected. There is no cessation of industries or prostration of trade, as commonly witnessed in this and other countries cursed by governmental management of the finances. In such countries, the greater the speculative fever the greater demand is there for more issues of legal-tender money, until the final smash comes, to recover from which it takes long years of prostration and of suffering. Our panic of '73 is a recent illustration of this process. The panic of '93 was produced by like causes,—the continual issue of government money,—and its effect would have been more disastrous and longer in duration had it not been for the heroic efforts made by the administration to maintain gold payments.

ABRAHAM MILLS.

Because of the clearness and force of this communication, Mr. Mills was immediately invited to prepare the following paper.—THE EDITOR.

The science of money is almost as abstruse as that of mathematics, and yet every wayside farmer and Knight of Labor is quite sure he knows all about it. Their representatives in congress are, therefore, compelled to vote for what will meet their views, on the penalty of losing their seats. This is the reason it has hitherto been so difficult to get any remediable legislation through congress. But we are rapidly learning our lesson, and in this readiness to be educated lies the great hope of those who think well of the republic. The plain people can be depended upon to act right when they see the right, and it is not too much to say that they see it now. What bothers them most is to discover how to get out of their troubles.

The difficulty of reconciling so many diverse views makes many acute thinkers despair of any improvement, until another panic and a general smash-up shall force the sound men of both parties to unite for the common welfare. When such an eminent publicist as Senator Mills says, as he did in his late speech recanting his silver heresy, that he is deathlessly opposed to banks, and that the sound Democratic doctrine is the providing of all money by the government, one may well despair. An unaccountable hatred of banks of issue is undoubtedly prevalent at the south and west, and derives its strength from the greenback experiment of the war times, and from utter ignorance of the true functions of such banks. In fact, the strength of all cheap-

money schemes in this country lies in the absence of local banks to do the actual and legitimate business of each community. It is safe to say that every enterprising man in the rural districts is at this moment sadly hampered in his operations by his inability to obtain currency upon his perfectly good note. That would be simply changing a portion of his fixed capital into current funds, which would be retired when their work was done by being redeemed at the bank of issue. As things are now, he cannot get the necessary facilities to conduct his business, and he cries for any money and plenty of it, without regard to its quality. This demand is a legitimate one, and it points the way out of the currency scrape we are in. Most thinking men have finally come to the conclusion that it is high time we did so, and that the first step is for the government to go out of the banking business. We must leave the management of the finances to the banks and bankers, which is their legitimate business. The currency would thus be subject to the laws of trade, which are as certain in their action as the rise and fall of the tides. Every business man would then know exactly how to act, and every operation would be based upon well-understood conditions. Banish this spectre of a currency panic, and can any one doubt where the enormous accumulation of gold in Europe would go to find profitable employment? This country alone in the whole world offers a field for its use. We don't get it because our public men do not know how to invite it, but, on the contrary, industriously repel it by their silver propaganda and futile discussions.

In the face of these recognized evils, the inertia of our legislators is so evidently absurd that one must seek for a motive sufficiently strong to induce them to persist in their folly. This can be found in the delusion of their farming and debt-loaded constituents that the prices of their products are depressed by the gold standard, and that nothing will save them from ruin but the silver basis. They seem to think that this alone will enable them to compete with the other silver currency countries of the world. By this means they hope to get for their products double the price in silver that they now get in gold. But they are beginning to understand that silver will purchase only half as much of what they must buy; and indeed not so much, as the risk of dealing in a debased currency always adds to the cost of the article bought. The question of wages—the great element of cost in agriculture—also confronts them, and they have horse sense enough to know that they could not long obtain labor in this country for a nominal dollar which would have the purchasing power of 50 cents. Likewise the mechanic is finding out the true meaning of a debased dollar; and so also are the owners of the $5,000,000,000 now invested in saving banks and life insurance companies and coöperative societies.

The debtor class is also frequently cited as one which demands a silver dollar with which to pay its debts. But there are now few, if any, mortgages, or any other obligations, which were not contracted upon a gold basis. This, therefore, is a contention merely for the repudiation of one-half of such indebtedness. In this matter we can also trust the people. Deluded for a time, they are not essentially dishonest, or so reckless of the necessity of public good faith as to deliberately endorse any course of action which squints another way. They are awakening likewise to the fact that the largest debtor class consists of the great corporations, savings banks, and insurance companies; and they don't propose to relieve them of their obligations to the mass of the people at half price. So, on the whole, the chances in favor of the *dèbacle* of free silver coinage is distinctly favorable. We can now turn our attention to the most serious question of the hour: how to get out of the scrape we are in, and how to mend our ways, that we may avoid trouble in the future, and ensure that prosperity which is fairly knocking at our doors for a chance to live.

Now, what is the trouble? It is the making of money by the general government, and its utterance without reference to the laws of trade and against all financial experience, which has demonstrated, over and over again, that no people can do this without ultimate disaster. We thought we could escape the inevitable penalty by offering to keep this paper at par in gold. So we could as long as the issue was limited to that already existing at the time of gold resumption in 1879. But, with the issue of silver dollars and silver notes came a monthly inflation of fiat money. The bubble was certain to burst the moment the balance of trade went against us. It has burst, and since 1893 we have been making heroic efforts, by resorts to all kinds of expedients, to keep that paper at par. The foreigner looks with derision at the spectacle of the richest and most enterprising people in the world suffering from their ridiculous experiments with the immutable laws of finance. This is the more humiliating when it is recognized how usefully we could employ real money in developing a country like this, and that we cannot get it, at a time when there is such a plethora of gold in Europe as was never known before, which is daily and weekly being augmented from the African and Australian mines. Our own capitalists are at one with the foreigner in distrusting the soundness of the financial situation of this country. Otherwise money would not be loaning at 1 per cent. per annum in Wall street. Nor would there be an almost absolute cessation of railroad building and of other great operations which ordinarily absorb idle capital in this country.

So it comes about that the one thing needful for the capitalist, the laboring man, and everyone who has a living to earn, and even the

widow and the orphan, is that our finances should speedily be put upon a sound basis. It must be done this winter, if we are to escape another collapse next year. The paramount question, however, is what? There are any quantity of doctors for the sick patient, but, while all agree in their diagnosis, they radically differ as to the treatment. They acknowledge the government must take steps to go out of the banking business and rid itself of its health-destroying paper money; that it must shake off the responsibility of carrying the ultimate gold reserve, —the only monetary basis the world accepts,—and put it upon the banks, or, in other words, upon the trading community itself. Why the doctors don't agree is because they are not skilled physicians, but simply "bone setters." Lawyers and farmers and professional politicians are not the people to meddle with such an exact science as finance. Up to this time it has all been in their hands, and a sad mess they have made of it.

Now, I venture to say that in an hour one could get together in a bank parlor in Wall street half a dozen men who in another hour would formulate a practical plan to lead us out of our difficulties. I imagine that they would agree that the way is to get rid of the government's demand obligations as fast as practicable, either by paying them off, or by funding them, or both. That is the basis of action. The *method* is the troublesome point, since these demand obligations are the only money of the people, and you cannot take it away without substituting something else, *pari passu*. There are nothing but bank notes with which to do it, and these must be furnished by free banking,—preferably under the Canadian plan of issuing notes under government supervision against the capital of the banks, with an adequate cash reserve of about 25 per cent. of the note issue. The present national bank system may be continued, excepting as to the provision of securing their note-issues by government bonds. There are several objections to this. A bank's capital is locked up as soon as it starts by the purchase of these bonds; and the people's representatives seem bitterly opposed to paying interest on such bonds, while at the same time paying interest for the use of the bank's paper. Another point which must be considered is that, if a new loan is sold abroad to obtain gold, a large part of the issue will inevitably be sold back to this country to be used against bank-note issues, and so defeat the end in view in issuing the bonds.

The short road out of the difficulty which every clear-headed person advocates is to fund the greenbacks. Before this can be done, however, something must be provided in which the new banks can hold their reserves. People talk glibly of all the gold there is in the country. But one cannot go by faith in such a matter,—only by sight.

All the gold we know of outside of the treasury is exhibited in the weekly returns of the banks in the larger cities, and they are not likely to part with it. Of course the necessary amount of gold might be forthcoming, if all the currency were funded. That, though, would be only after an era of panic prices, sufficiently great to bring gold here from abroad for investment. No one would venture to recommend such drastic measures, much less to make laws to bring them about. The bank's reserves must, therefore, necessarily be in the present legal-tender notes, until such time as that currency would be supplanted by something else, or so much of it that the remainder would be no longer a menace. This brings us to the question how to pay it off, or, in other words, how to substitute gold for the notes. We can do it only by getting back some of the enormous amounts we have shipped to Europe, where it is a useless burden to the banks.

The most practical way to accomplish this is by opening a credit for a large amount in London against our 3 per cent. bonds,—in short, by the hypothecation of these bonds for a certain period. During the time that the government is playing at being a banker it must be one seriously. It must get its necessary gold on the best terms it can, and by the use of its credit. There is no novelty in such a proceeding, as we have lately had many examples of currency reforms effected in this way by other countries,—notably Chili and Austria. The details of the plan are immaterial. Supposing, for instance, that the secretary of the treasury were authorized to borrow as much gold as he needs against the pledge of the bonds above alluded to. Drawing upon this fund and thus gradually redeeming his demand notes, he gets rid of the latter, and at the same time replaces them with gold, which gold will take their place in the banking reserves. The mere fact of taking this step would dissipate the fears of Europe as to the soundness of our currency, while at the same time exchange would go down from the sale of the government's bills. Gold would naturally be sent here so largely that the currency question would cure itself with but moderate borrowing on the part of the government. Another good result would be that, with confidence in the government's solvency, the banks of the larger cities would return to their former commendable plan of paying checks in gold for duties, and thus giving the government an independent gold revenue, which it does not get now, as all duties are paid in legals.

But what shall we do with the enormous load of silver bullion in the treasury? In any scheme of currency reform this problem must be considered. It cannot be sold *en bloc*, as there is no market to take such a huge pile. A possible solution of the difficulty could be

arrived at, if all the legal tenders and bank bills under $5 were retired and no more issued, thus making a place for silver dollars. France keeps an enormous quantity of silver 5-franc pieces afloat in this way.

With some such reformation of the currency, what may be reasonably anticipated? In the first place, that greatest of desiderata—the taking of all currency questions out of politics—would be accomplished. No scare would then come over every man of affairs at each meeting of congress. Secondly, we should have established an automatic gold reserve in the coffers of the banks, ever responding to the natural laws of trade, and requiring no paternal interference whatever from the government. This accomplished, that sudden chill and semipanic which now comes over every exchange of the country and disseminates itself into every mart of trade and finance wherever a paltry million of gold is exported would disappear.

Something like this must be done on the penalty of a general smash. We cannot drift along in the present makeshift and trembling sort of way. It may not be too much to hope, then, that congress will finally rise to the occasion. A brilliant future lies immediately before this country, with possibilities of great prosperity and even the commercial rule of the world. We have made the first step in progress by reducing our tariff in such a way that we are beginning to compete in our exports of manufactured goods with nations which have hitherto held a monopoly of that trade. Another cause which should have a most potent influence to induce congress to promptly act is the wild speculation in mining stocks and in other crazy schemes which has seized upon the three great capitals of Europe. This has already gone to perilous lengths, and no serious man doubts that a tremendous crash will come sooner or later. That will be no time to negotiote loans or to reform our currency, as we shall inevitably be involved more or less in the financial smash.

A war in Europe must also be reckoned with! Day by day a mysterious, formless impression is growing in its capitals that at any moment their people may spring to arms over the Eastern or some other question. It may be postponed, or it may come as suddenly as did the Franco-German war. But every scheme of *haute finance* must reckon seriously with this probability.

In writing all this I am not unmindful of the adage: "Fools rush in," etc. My apology is that it is the duty and for the best interests of all who have made a study, and have had the facilities for acquiring a practical knowledge of, financial problems to try to impart what they have learned. Those who have not had such opportunities, but yet have the votes, may be depended upon to learn in good time. This is the way of our people.

TAXATION IN THE UNITED STATES.

By Edward Atkinson.

IT is becoming evident that the most urgent problem with nearly every government in the world is how to secure a sufficient revenue without impairing the productive energy of the people of the several nations or States by which continents are possessed. This question is as urgent in some of the richest sections of the globe which have been but recently opened to civilization and commerce as it is in some of the older States in which the limit of taxation has been reached, accompanied by national bankruptcy or a resort to a forced loan by the issue of legal-tender paper money.

It is desirable to compare the relative burden of taxation, and to that end the following statement of the amount of taxes and method of their assessment in the United States is submitted.

The tables give an analysis of all taxes imposed in the United States for national, State, county, and municipal purposes.

The principal source of information on which these statements rest is the special census report made by Mr. J. K. Upton, special expert of the census department of the United States, by whom the receipts and expenditures of national, State, and local governments in the census year 1890 have been compiled and published. The statistical data which are not derived from this report are derived from the official statements of the United States treasury. The estimates of the value of the national product are based on various authorities and upon my own investigations.

Total amount of revenue collected in the census year 1890 for all purposes	$1,040,473,013
Collected by the national government, including postal revenue	461,154,680
Collected by cities and towns, partly estimated, for expenditure by cities, towns, and customarily by counties and States	329,635,200
Collected for expenditure by counties, partly estimated	133,525,493
Collected for expenditure by States, territories, and the District of Columbia	116,157,640
Total	$1,040,473,013
Total expenditures by national, State, and local governments for all purposes	$915,954,055
Sum applied to the reduction of public debts	124,518,958
	$1,040,473,013

GENERAL DIVISION OF THE EXPENDITURES.

Expended by the national government, including the postal service.	$352,218,614
Deduct the postal service, which is mainly recovered from the sale of stamps,—there being a slight deficiency, varying year by year, which is covered under the general expenditures	66,259,547
	$285,959,067
Expended by States, territories, and District of Columbia, except for public schools	77,105,911
Expended by counties, except for public schools, partly estimated, in the division with cities and towns	114,575,401
Expended by cities and towns, except for public schools, partly estimated as above	232,988,592
Expended for public schools	139,065,537
Net cost of government	$849,694,508

Net cost of government per head of population.

$13.65 £2.8049 Francs, 70.747 Marks, 57.305

This expenditure, omitting postal service, may be classified as follows:

BENEFICIARY.		
Pensions paid by the United States government	$106,936,855	
State and municipal charities	39,958,816	
Support of Indians	6,708,047	
		$153,603,718
ADMINISTRATIVE.		
Support of civil governments	$266,412,130	
Support of army and navy	57,543,817	
		323,955,947
INTEREST ON PUBLIC DEBTS.		
National, State, and municipal	82,748,423	82,748,423
CONSTRUCTIVE.		
Support of schools	145,583,115	
Construction and maintenance of highways	72,262,023	
Construction and maintenance of public buildings, libraries, and parks	59,803,844	
Improvement of rivers and harbors	11,737,438	
		289,386,420
Total		$849,694,508

The charges to which the people of the United States are subjected, aside from the reduction of public debts, therefore amount per head of population to the following sums:

	$	£	Francs.	Marks.
For beneficiary purposes	2.47	.5075	12.802	10.369
Administrative	5.20	1.0685	26.951	21.830
Interest	1.33	.2733	1.893	5.583
Constructive	4.65	.9555	24.100	19.721
	13.65	2.8048	65.746	57.503

The area of the United States, omitting Alaska, is a fraction under 3,000,000 sq. miles of 640 acres each, equal in the aggregate to 1,920,000,000 acres, upon which the charge of $849,694,500 comes to a fraction over 44 cents per acre. Less than one-fifth part of this area is under the plough; probably one-half is arable land; probably 25 per cent. in addition is valuable as forest or suitable for pasture; the remainder consists of mountainous sections, or, in small part, of arid desert. These are merely general statements, not intended to be exact. The charge or tax for public purposes, if assessed wholly upon the portion of the land which is in productive use or under the plough, would average approximately $2.00 per acre. But it will be remarked hereafter that a large part of the municipal assessment is upon real estate in cities. It is not probable that the tax which falls upon the owners or occupiers of arable or pasture land comes to an average of $1.00 per acre.

A more important consideration is the proportion of taxation or public expenditure to the gross income of the people. It is, of course, impossible for any one to reach other than an approximate estimate upon this point. Official estimates are made by the census authorities and by other officials of the value of farm products at the farms, of the value of forest products at their source, of the value of mining products at the mines, and so on. We also have data regarding the value of manufactured products at the factories. But there are of necessity a great many duplications in these estimates, which cannot be wholly eliminated,—as, for instance, the conversion of grain into meat and dairy products; the conversion of wood and metal into buildings, tools, and implements; and the conversion of fibers into fabrics. I do not, therefore, regard these computations as anything but material to be applied for the purpose of estimating the annual income or product. They would be sure to mislead, on account of these necessary duplications, if accepted as final.

I have in several instances extended the valuation of the crude products of the country through their various transformations into finished goods and wares by methods of a somewhat complex order, which have been satisfactory to myself.

I have also proved the results of such estimates approximately by working from the known factors of the average earnings of all classes in the community who are occupied for gain,—adding taxes, profits, and other elements that enter into the cost of production and distribution. By these methods, which are dealt with in my book upon "The Distribution of Products" (G. P. Putnam's Sons), I have satisfied myself that the value of our national product in 1880, at the points of final distribution for consumption, came to $200 per head, including that part of each crop which is consumed upon the farms.

In the interval between 1880 and the census of 1890 the quantities of nearly every product were greatly increased; the cost was diminished; the means of distribution were augmented; the wage or proportion of product falling to those who are customarily named "the working class" was largely augmented; but the prices of nearly every important class of products were much lessened at the points of consumption, although maintaining a relatively steady value at the points of production.

There is, of course, a very great variation in the distribution of such taxes, the taxes in cities being ratably very much higher per capita, or by the measure of property, than they are in the agricultural districts.

Of this sum total of local taxation the amount collected by direct *ad valorem* taxes upon real estate was $443,096,574. The remainder was derived from special taxes on franchises, licenses, and other minor sources.

It therefore follows that about one-half the total revenue collected from the people of the United States for all purposes is derived from direct taxes upon property, and about one-half from duties, excise taxes upon articles of common or general consumption, or licenses and taxes on franchises. This division may be justified in consideration of the fact that the protection of property, the provision for highways, and other similar functions, rest upon the States, counties, and towns, while national defence and the protection of persons and the establishment of personal rights at home and abroad rests upon the central government.

Taxes for the support of local self-government are therefore mainly collected from assessments upon property; the revenue for the support of the national government is collected almost wholly from articles of common consumption.

The foregoing memorandum is submitted with a view to the adoption in other countries, or by officials thereto designated by the United States government, of some method of ascertaining and sorting the respective revenues and expenditures of other countries, to the end that the relative burden of taxation and the relative cost of conducting the governments of nations, States, or municipalities may be compared.

The undersigned has made an attempt to set off the items of revenue and expenditure of this and other countries one against the other, but has failed, the reason being that the methods of accounting differ greatly. It is therefore difficult, if not impossible, for one who is not conversant with the systems of account in other countries to set off the several items of expenditure, or even of revenue, one against the

other, with any certainty or precision. The following reasons for this undertaking are submitted.

The world is becoming more and more a neighborhood of which the different members can and will supply each others' wants in a continually increasing measure, to the profit and benefit of all who are served by the conduct of commerce, the surplus of one nation being exchanged against the surplus of another to the mutual profit and benefit of all. This interdependence of States and nations has asserted itself throughout the last century in spite of wars, conventions, treaties, tariffs, variations in the unit or standard of value, and all other obstructions.

It is manifest that by far the greater part of the commerce or exchange of services among men is of necessity limited to the domestic traffic. The international exchanges constitute a very small proportion compared to the home trade. But, on the other hand, diversities of climate, soil, and conditions create international commerce, whereby one nation may relieve itself of an excess of some product, the other securing what it requires. It is noticeable that in the early part of this century and the latter half of the last this commerce asserted itself so strongly as to have led the smugglers by whom the prohibitions of the tariff of the era were overcome to be called the "fair traders," the legal fault being condoned in public estimation.

During the last half century the applications of science and invention have rendered international commerce more and more necessary and useful. We can already foresee yet greater and more beneficent influences from the applications of modern science in the opening of the ways of commerce both by the canals already constructed (yet more when those which are planned shall be completed) and by the extension of the railway and steam-ship service in continents which have only been opened to trade within the present generation.

The Suez canal has brought Asia and Europe into a close neighborhood. The projected canal between the Atlantic and the Pacific, if constructed, will alter the balance of the trade of the world. The canal which unites the great lakes in the United States around the falls of Sault Ste. Marie has exerted a most beneficent influence both upon the United States and Canada, bringing the timber, the ores, and the grain of the far north-western territory to the uses of the bread-winner in the eastern parts of the United States, in Great Britain, and upon the continent of Europe.

The annual tonnage which passes through the Sault Ste. Marie canal, 300 miles north of Detroit, at the present time far exceeds that which passes through the Suez canal year by year. The opening of the canal at Kiel may be noted as a notable event in peaceful commerce.

To whom, then, will fall the paramount influence in the next half century? It is with reference to this matter that the problem of comparative taxation assumes great importance, since one great factor, if not the prime factor, in the effort of one nation in competition with others for the supply of the wants of the world consists in the relative burden of taxation. All profits, rents, wages, earnings, and taxes must be derived substantially from the annual product, a small part of the product of the preceding year being brought over to the present, and a corresponding part of the current year's product being carried over to the next. On the whole, mankind is always within 1 year or less of starvation, and within 2 or 3 years of being naked and homeless. The commerce of the world must of necesssity go on in order that mankind may continue to exist, while the comfort and welfare of great masses of the people of every country will be commensurate with the freedom with which this commerce is conducted and the lessening burden of what may be called the destructive taxation of war or the constant preparation for war.

Regard being given to the burden of taxation, its relative influence upon the welfare or illfare of the people consists not so much in its proportion to the gross product as in its ratio to the margin of profit which may be derived from agriculture, manufactures, or commerce. That profit, whatever it may be, is the incentive to the capitalist to develop all the arts, both of production and distribution. If we compare the ratio of taxation of any State or nation to the gross value of its annual product, it may not appear a very serious matter. If we, however, compare the rate of taxation with the probable ratio of profits that may be derived from any particular art, it becomes manifest that the most lightly taxed nation will secure the largest profit, and may therefore take to itself the greater share in production.

If it should be proved by comparison of the relative burden of taxation, on the plan of the present paper, either in ratio to population, in ratio to arable land, or in ratio to the net profit which may be derived from production, that the burden of constant preparation for war had become unbearable, and can be no longer borne without disaster; if it should be proved that the destructive taxation for war purposes is the prime cause of want and of pauperism,—then the remedy for such wrongs may be in sight. If it should prove that the nation which contains within its own area the greatest natural resources, the best schools, and the smallest army, and which supports a navy only for the protection of commerce, and not for its destruction, may hold the paramount position among the machine-using States and nations, then it would follow of necessity that the principle of liberty must prevail, and must lead in the end to the removal of militarism and of

government by privilege, and, lastly, to the abatement of the corresponding evils of Nihilism and Communism, which are the complement of government imposed from above without the consent of the governed.

It is to this end that I suggest to my coadjutors in economic science the expediency of devising plans and methods for establishing a systematic study of the comparative taxation of different countries.

The advance in money value is not, therefore, to be estimated at the same ratio with the increase in quantity. I am satisfied that the annual product of the census year 1890 divided by the population amounted approximately to $225 per head. On this basis the gross value of our annual product in 1890, disregarding small fractions, came to $14,000,000,000. The net expenses for national, State, and municipal purposes in that year amounted to $849,694,508, showing that a fraction over 6 per cent. of the total product was devoted to the support of government.

The margin of error in this estimate is not large. It may be affirmed with almost positive certainty that the proportion of the product assigned to the support of the government in 1890, and to such payment of public debts as was made in that year,—a total of $1,040,473,013,—could not have been less than 6 per cent. of the gross product, probably amounted to 7 per cent., and could not have exceeded 8 per cent., the variation in per cent. depending upon a greater or less valuation of the product.

The next point which calls for attention is the relative burden of the national taxes as compared to those which are assessed for State and municipal purposes.

In 1890 the total expenditures of the United States government, less the postal service, amounted to $291,028,440.

	$	£	Francs.	Marks.
Per capita.....	4.749	.9578	24.614	19.957

This sum could not have been less than 2 per cent. upon the annual product, and could not have exceeded 2½ per cent.

The average expenditures of the United States government for 15 years, from 1880 to 1894 inclusive, have been very nearly the same as the ratio in 1890,—at times a little less, later a little more.

Under the present administration these expenditures are being diminished ratably to population.

The average annual per capita expenditures for a period of 15 years has been as follows:

$	£	Francs.	Marks.
4.89	1.0048	25.345	20.525

The revenue of the national government is almost wholly derived

from duties upon imports and excise taxes on liquors and tobacco. The government has a small income from sales of public lands, taxes on bank-note circulation, and other small factors which do not need special treatment. The following tables give a general conception of the sources of national revenue from 1880 to 1893.

Tax on domestic spirits, yielding per head	$1.312
" " " beer " " "	.373
" " " tobacco " " "	.605
" " foreign liquors " " "	.137
" " " tobacco " " "	.160
Total tax on liquors and tobacco	$2.587
Tax on sugar for the first 11¼ years, at the rate of .925 per head, tax then removed:	
Average for whole term	.764
Small internal taxes	.077
Miscellaneous permanent receipts, sales of public lands, etc	.534
	$1.375
	$3.962
Duties on all other imports than liquors and tobacco	2.576
Total taxation per head	$6.538

The subsequent table gives the expenditures in detail for 15 years, 1880 to 1894 inclusive.

The average cost per head of each department of the national government, aside from postal service, for 15 years has been as follows:

Cost of civil service administration – legislative, judicial, consular, etc	$ .39640
Public buildings for civil use – post-office, custom-houses, etc	.07386
Support of army	.56610
Cost of forts, etc	00600
Improvement of rivers and harbors	.18600
Support of navy	.25260
Construction of naval vessels	.08826
Miscellaneous—District of Columbia, etc., refund of taxes, unlawful sugar bounties, premium on bonds purchased, etc	.92266
Total	2.49188
Interest on public debt	.90880
Cost of government and interest	3.40068
Pensions	1.48760
Total expenditure	4.88828
Taxation for national purposes in all forms, per head	6.53800
Expenditures of all kinds	4.88828
Difference	1.64972

Making no allowance for a slight difference in cash in the treasury on June 30, 1879, as compared to June 30, 1894, this difference of $1.65 per head enabled the treasurer to meet the postal deficit, to pay for the support of Indians and for extinguishing their title to large areas of Indian land, and to reduce the public debt by over $1,100,000,000, besides paying a heavy premium on the bonds purchased.

The national debt at its highest point, a few months after the end of the civil war, was a fraction under $3,000,000,000. It had been reduced to less than $1,000,000,000, when new loans were effected to the amount of about $500,000,000 for the purchase of silver bullion, which rests mainly in the treasury in the form of silver dollars or of uncoined bullion. If that reserve or deposit of silver is estimated at its market value and deducted from the present debt of the United States, the net amount which we now owe is approximately $1,100,000,000.

It is now manifest that, in the natural course of events, the per capita expenditure of the United States will diminish ratably to the population by the falling in of pensions. It may therefore be assumed as approximately certain that a continuation of the national taxation at the present amount of $5.00 per capita will meet all the expenses of the government, with a sufficient surplus to pay the remainder of the national debt within the next 20 years.

The taxes which are imposed for city, county, and municipal purposes are assessed almost wholly directly upon property. The method of assessment varies in the different States. It is customary, however, for these taxes to be levied in one assessment. In New England, which is under the town and city system of government, all the taxes are assessed by town and city, the sum required by the county being paid over to the county, and the sum required by the State being paid over to the State.

Total expenditures in 1890 for the cost of local government	$558,666,068
To which may be added the sum applied to the reduction of State, county, and municipal debts	15,582,892
Bringing the total assessment to	$574,248,960

The amount of this assessment per capita was as follows:

$	£	Francs.	Marks.
9.22	1.8946	47.787	38.707

CONTEMPORARY ENGLISH ARCHITECTS AND THEIR WORK.

By H. Heathcote Statham.

THE aims and characteristics of English architecture at the present moment are essentially different from those which have prevailed in England during the previous portion of the century; so far, that is to say, as respects the work of those who in an artistic sense are her leading architects. There is no doubt a great amount of dull, commonplace, almost mechanical architecture, not worth calling "design," carried out by people who have what is called "a large practice" and who have achieved a commercial success; and there may perhaps be a larger proportion of such work, in comparison with real architecture, than is found in France or in the United States, though, in regard to the latter, I can judge only from published illustrations. But, if we take the men who are admittedly prominent among the English architectural designers of the day, I believe it will be found that in regard to quality, if not quantity, English architecture is not inferior to that of any other nation at the present moment. The French, it must be admitted, are superior to all the world in the planning, designing, and detailing of a large and grandiose building of the classic type, but it can hardly be questioned that English architects could give them many a lesson in the qualities of grace, variety, picturesqueness, and refined taste in buildings of a less pompous class. The development of original and picturesque types of architecture, especially domestic architecture, of late years in the United States has been watched with much interest from our side of the Atlantic, but I do not think we could reasonably be expected to feel that the American architects are our superiors in this respect, except in so far as they have larger and more extended opportunities.

For the essential change in English architecture, referred to above, consists in the fact, that we are at last really beginning to shake off mere revivalism. In the Gothic revival everything ran in one groove, and the most learned and conservative revivalist was considered the best man; and, when the "Queen Anne" revival took its place, it was prophesied that this was only the commencement of another phase of copyism. But the result has turned out otherwise. Partly perhaps because the phase of architecture seized upon was in itself less pure, less perfect, less of a real "style," than the Gothic, the generation which began by adopting the manner of the Queen Anne or

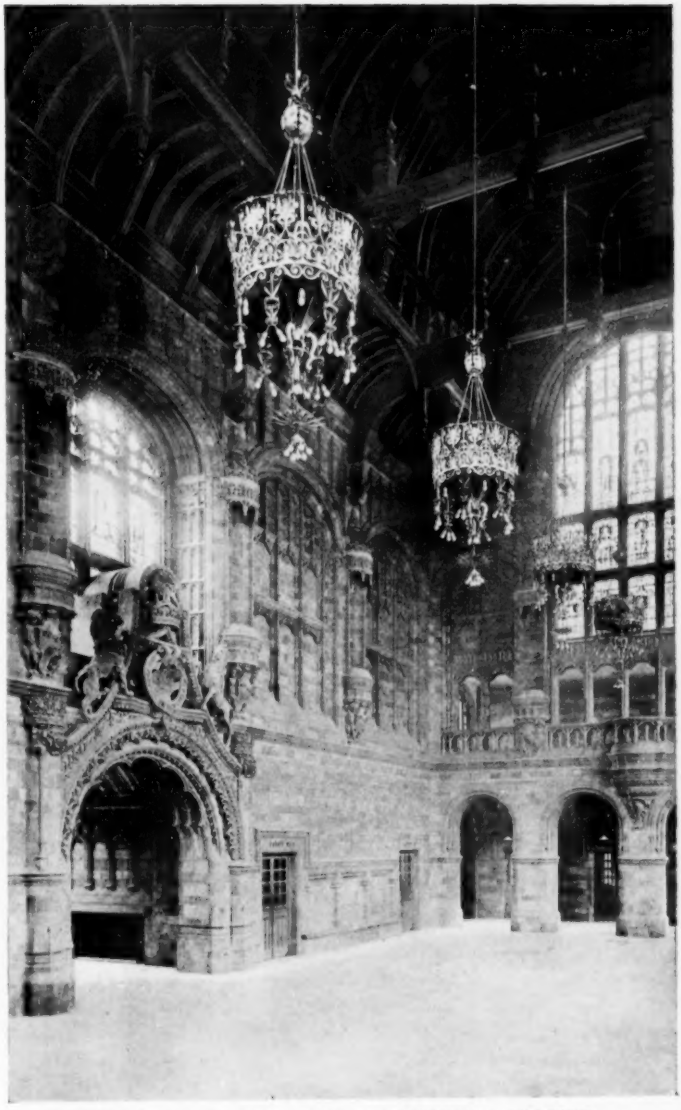
CENTRE BLOCK NATURAL HISTORY MUSEUM, SOUTH KENSINGTON.
BY MR. A. WATERHOUSE, R. A.

Jacobean architects has not remained bound to this, but has developed it in various directions, in buildings which are by no means mere reproductions of a style of the past, but which display at all events perfectly novel combinations of old materials, and such as give every promise of further development. To a slight extent English domestic architecture on a small scale has taken some hints from what I venture to call the *ultra*-picturesque type of country-house recently developed in America; but this only occasionally. In the main I think it may be claimed that the best recent work of English architects is as original as anything that their American cousins can show.

Mr. Waterhouse, whose name is perhaps more widely known than that of any other English architect of the day, belongs artistically rather to the last than the present generation. He rose into fame, in the first instance, through his Manchester assize courts (which he gained as the result of a very large competition), when the Gothic revival was still in full swing; but he was no mere revivalist. In his adaptation of Gothic to municipal structures, street buildings, and modern domestic architecture, he evolved a manner entirely his own, which was recognizable at a glance, and which received the compliment of imitation on a most extensive scale. Now that the taste for medievalism has declined, his work of this type is unjustly depreciated by many of the younger men of the day, who forget that, in carrying it out, he was only doing better than most others what every one was doing at the time. Of late Mr. Waterhouse's style has been a good deal modified, and is now more eclectic than formerly. He was largely instrumental in the introduction of terra-cotta facing in place of masonry, and no doubt one result of this, both in his own terra-cotta architecture and that of his imitators, has been to lead to a too great exuberance of detail, a want of repose. This is the defect in his largest building of this type, the Natural History Museum at South Kensington. Yet there is no large English building of the day which has more decisive claim to originality. It resembles nothing that preceded it, and cannot be pigeon-holed under any archæological formula. Moreover, Mr. Waterhouse has been throughout his career a thorough architect, in the most complete sense of the word. He is a master of the art of planning, a subject in which some of those who dislike his school of design might well take lessons from him, and in every other sense has always had a thoroughly practical grasp of the art of building.

Mr. Aston Webb may perhaps be considered in a sense the legitimate architectural inheritor of Mr. Waterhouse; not that he consciously imitates the style of the former, but he holds very much the same kind of position among the younger generation of architects.

PART OF STREET FRONT, NEW LAW COURTS, BIRMINGHAM.
BY MESSRS. ASTON WEBB AND INGRESS BELL.



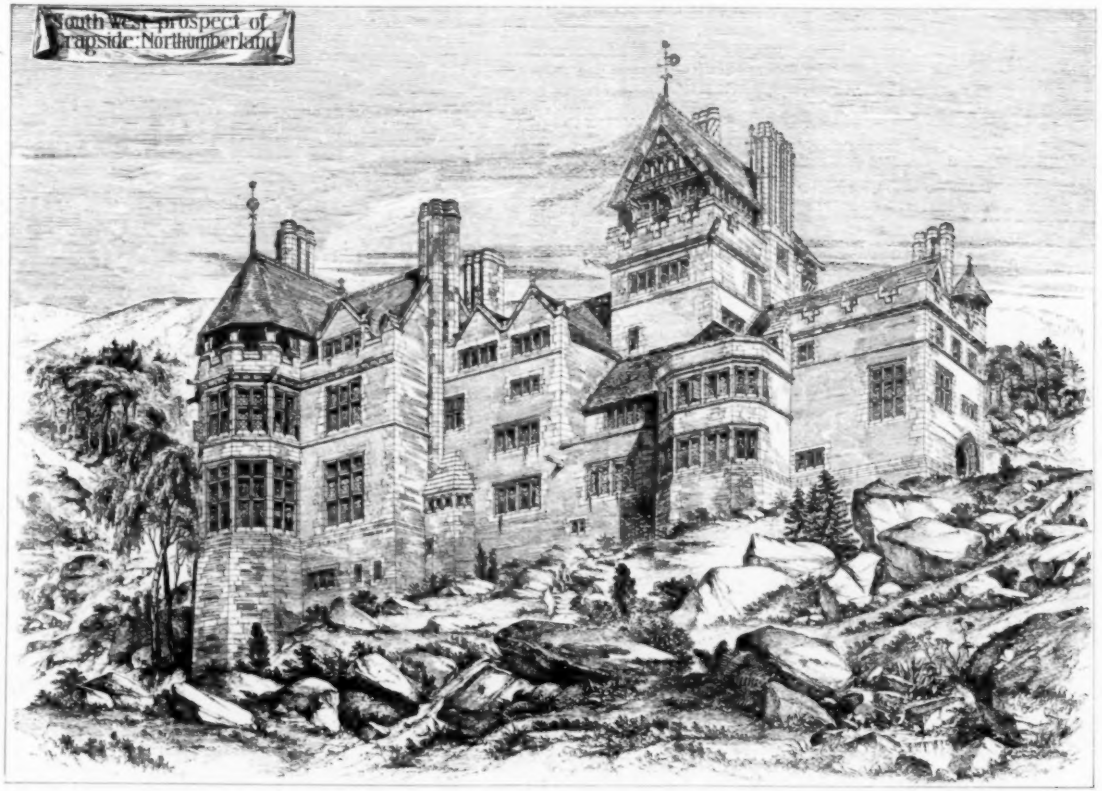
CENTRAL HALL, NEW LAW COURTS, BIRMINGHAM. BY MESSRS. ASTON WEBB AND INGRESS BELL.

Like Mr. Waterhouse, he is a master of plan; like him, he is apart from the newer tendencies of English architecture, and is not regarded with much sympathy by the adherents of the new school. His Birmingham law courts, won in competition in conjunction with his friend and frequent coadjutor in large works, Mr. Ingress Bell, is a terra-cotta work, in which the facilities given by the material for luxuriance of detail are carried further than Mr. Waterhouse ever carried them, and certainly I think too far, though the picturesque general effect of the façade cannot be questioned, any more than its originality and novelty. Moreover, the Birmingham law courts is one of the best planned buildings in England, old or new. This building mainly raised Mr. Aston Webb to his present position among English architects, but it has since been his fortune to win two of the most important competitions of the day,—those for the completion of South Kensington Museum and for the proposed "Christ's Hospital" schools at Horsham, the carrying out of both of which appears to be indefinitely postponed for want of funds. The Christ's Hospital design, won in conjunction with Mr. Bell, is one of the most remarkable plans I have ever seen, and, if the building, or, rather, series of buildings (for it is a little town in itself), is ever carried out, it will go far to revolutionize public-school planning in England. Mr. Aston Webb is a prominent member and vice-president of the Institute of Architects, and will probably be its next president.

The last remark serves *infandum renovare dolorem*. It is a matter of faith—nay, of ardor and burning zeal—among several of the best men of what may be called the new school of English architects to have nothing to do with the Institute, and even to scoff at and revile it when opportunity occurs. Why they adopt this attitude I do not know, and I do not believe they know themselves; at all events, I have never heard any logical or intelligible reason for it. As far as I can understand, the opposition professes to be based on the theory that architecture is a pure art, like sculpture and painting, and that the Institute treats it as a science and a profession also. It seems to me that facts and common sense are on the side of the Institute; but one cannot well enter on so large a question here. I will only remark that, while it must be admitted that very bad *designs* have been made by architects who are members of the Institute, some of the worst *plans* ever made have been produced among the "art-architects" who despise the Institute.*

* It may be as well to add, perhaps, that it is "common knowledge" that some of the outsider architects who consider themselves artists *par excellence* have commercial interests in firms producing artistic fabrics of one kind or another, and this fact would in itself debar them from membership of the Institute, which maintains in its by-laws the wholesome provision that its members shall have no commercial interest in the sale or employment of any material used in building.

OFFICE, ALLIANCE ASSURANCE CO., ST. JAMES ST., LONDON. BY MR. R. NORMAN SHAW, R. A.



"CRAGSIDE," NORTHUMBERLAND. BY MR. R. NORMAN SHAW, R. A.

Facile princeps among these irreconcilables, and perhaps among English architects, is Mr. Norman Shaw, R. A. ; at least, if a *plebiscite* were taken as to who was our leading architect, I think he would come in by a large majority, though, oddly enough, he has never had the chance of producing any building on the largest scale, and his work is mostly either domestic or street architecture. And, if it be admitted that the great object of architecture is to make buildings interesting, I do not know where Mr. Shaw's equal is to be found, either in France or America. His variety of treatment seems endless ; he never repeats himself, and, while he adopts many details which are to be found in Elizabethan, or Jacobean, or Queen Anne architecture, they do not suggest copyism ; they are combined and treated in a manner of his own ; they may be details often corrupt in themselves, such as the pyramid finials of one period of English Renaissance, but there is a charm about the grouping of the whole which is entirely his own. It is seldom very easy, either, to label or classify Mr. Shaw's buildings as to style ; and, as long as the result is pleasing, that is one of the best things you can say about a design. There are two tendencies discernible in his buildings, some of which incline more to late medieval types, others to late Renaissance : "Cragside," Lord Armstrong's house, is an example of the one, the Alliance assurance offices in St. James's street of the other. Mr. Norman Shaw, too, is no mere artist in architecture, but a practical constructor and the inventor of a new form of house drain which has been a good deal used. What he would have made of a grand building on the largest scale, such as a first-class town hall, we have had no opportunity of knowing ; possibly his style might not have come out so successfully or suitably in that form ; but at all events we owe to him an almost unprecedented number (for one man) of picturesque and interesting buildings on a medium scale. The most important public building he has carried out, the block of police buildings at New Scotland Yard, is, however, a great success, and is marked by a curious bit of original character ; the walls were commenced in granite provided by convict labor, the supply of which was for some reason stopped when the building was about one-third up : the architect merely finished off the granite at a course level and went on in brick, without even an intervening string-course ; and this naïve acceptance of the situation gives half its character to the building.

Mr. T. G. Jackson, A. R. A., another of the "Irreconcilables," and the last architect elected member of the Royal Academy, has founded his style mainly on late Jacobean architecture, and, with less of picturesqueness and variety than Mr. Norman Shaw, and more conservative in his tendencies, has established a deserved reputation for

refinement and grace in the treatment of neo-Renaissance architecture. He has become in an especial sense the architect of modern Oxford, and in the new Examination schools and the new buildings of All Souls and Trinity Colleges and others, has produced architecture which has a remarkable affinity with the *genius loci*; so much so that, when some of his buildings get a little time-worn, it may be rather difficult to distinguish them in appearance and character from the buildings of the older date to which they are assimilated. This is perhaps going

NEWNHAM HALL, CAMBRIDGE. BY MR. BASIL CHAMPNEYS.

a little far, but his Oxford works nevertheless cannot fail to please from their refinement of detail, and it is on record that, when the London "Architectural Association" visited Oxford on their annual excursion 3 or 4 years ago, the members very quickly deserted Wren's chapel at Trinity to study in preference Mr. Jackson's buildings flanking one side of the "quad." In his school buildings at Radley and Uppingham Mr. Jackson has leaned towards late Gothic types, which he treats with equal refinement and good taste; and that he has versatility is further shown by his remarkable design for the decoration of a

OFFICES, LEADENHALL ST., LONDON. MR. T. E. COLLCUTT.

OFFICES OF THE CHARTERED ACCOUNTANTS, LONDON. BY MR. JOHN BELCHER.

piano in Intarsia work, which attracted great attention in London at the time. Another architect (also a non-Institute man) who has done a good deal of University architecture in a very refined manner is Mr. Basil Champneys. Though he has produced one or two charming buildings at Oxford, Mr. Champneys is better known at Cambridge, and more especially at Newnham, where his Newnham Hall is a charming specimen of a simple, but refined, architecture based on late English Renaissance, but with an original treatment of his own. Mr. Champneys did a good deal of Gothic work formerly, but seems now to incline generally to a classic type of design, which he always treats in a sober, refined, and reticent manner, and in which he has established a certain recognizable style peculiar to himself.

Mr. T. E. Collcutt, whose principal work, only just completed, is the Imperial Institute (gained by him in a limited competition of six architects), is an architect whose work has had a great deal of influence on that of his juniors in this generation. He early established a manner of his own, based on English Renaissance, which was as distinctive and well-marked as Mr. Waterhouse's early style based upon Gothic, and has had as many imitators. His general manner is well illustrated in the front of the offices in Leadenhall street, which is one of his most recent works. It is characterized by the combined employment of arches and pilasters, but always in a very flat manner, and with certain favorite devices peculiar to himself (at least until others began to imitate them), such as the termination of gables or pilaster groups with a little curved pediment, like that seen in the centre of the Leadenhall street elevation. When spread over a building the size of the Imperial Institute, this style seems rather wanting in force, but it is always refined and pleasing. The Institute is a well-planned building; the central hall is a fine interior with a timber roof treated in a very original and effective manner, and the upper portion of the tower is a good piece of design.

No work of the neo-classic school has excited more interest recently in London than Mr. John Belcher's offices for the Chartered Accountants, in the city. As will be seen from the illustration, it exhibits a use of classic details in a remarkably bold and unconventional manner, and this novelty and independence of treatment pervades the whole building, internally and externally. This is the most note-worthy of Mr. Belcher's buildings; a book of photographic illustrations of it has been issued by Mr. Batsford, the well-known architectural publisher, and any of my readers who may procure this will, I think, agree that the illustrations represent a building of very remarkable character. All Mr. Belcher's designs are distinguished by original feeling, and his competition design for the completion of South Kensington Mu-

SOUTH FRONT, BATTERSEA TOWN HALL. BY MR. E. W. MOUNTFORD.

seum was a very remarkable effort, and one of the most powerful designs that has ever been submitted in a large competition.

Two other architects among the neo-classics may be named who are filling a considerable space in the English architectural work of the day. Mr. J. M. Brydon came prominently into notice some years ago by his design which gained the competition for the Chelsea Town Hall, and which was the result of an obviously very careful study of the architecture of the Queen Anne and early Georgian period, and was therefore especially suitable to the locality. Since then Mr. Brydon may be said to have become generally recognized as the architect best fitted to deal with that particular phase of English architecture, and, when he gained the competition for the new Municipal Buildings at Bath, it was generally felt that no one was better qualified to produce a building in harmony with the city which bears so much of the impress of the architect who in the last century was famous as "Wood of Bath." Mr. Brydon has since gained also, with equal suitability, the competition for the extensions to the pump-room and the treatment of the ancient Roman bath in the same city. The Chelsea Public Library, with its semi-circular colonnaded portico, is a good example of his work. The Battersea Public Library, of which an illustration is also given, is one of the recent works of Mr. E. W. Mountford, who gained some years ago the competition for the Sheffield Town Hall, and has won competition after competition since. In his style as exhibited in the Sheffield building he may be said to have owed something both to Mr. Waterhouse and to Mr. Collcutt, but in more recent buildings he has adopted a treatment more decidedly his own. Mr. Mountford was for the last 2 years the president of the Architectural Association.

Church architecture is a less prominent factor at present than it was in the days of the ecclesiological revival, but the commencement of a nineteenth-century cathedral in England—*viz.*, that of Truro, of which the choir and transepts are completed—is an important event, and its architect, Mr. J. L. Pearson, R. A., is one who is to be credited with something more than merely accurate revival of Gothic. The interior of Truro choir, certainly, is the most remarkable realization of the medieval spirit in church architecture that could be seen, — far more so than any of Scott's works,—but it is not mere copying; the building has its own points, not to be found in any medieval cathedral; and in the exterior treatment, both here and in his churches at Kilburn and Red Lion square (London), Mr. Pearson has given his own peculiar stamp to revived Gothic architecture. Mr. Jas. Brooks, who recently was awarded the Royal Gold Medal of the Institute of British Architects in recognition of his works, has built,

PUBLIC LIBRARY, CHELSEA. BY MR. J. M. BRYDON.

and is still building, large town churches whose plain and massive architectural treatment, mostly in a modification of early Gothic, but with a distinctly marked individual character, forms a welcome contrast to the florid modern Gothic of which we saw far too much during the earlier years of the present half-century. Mr. Leonard Stokes,

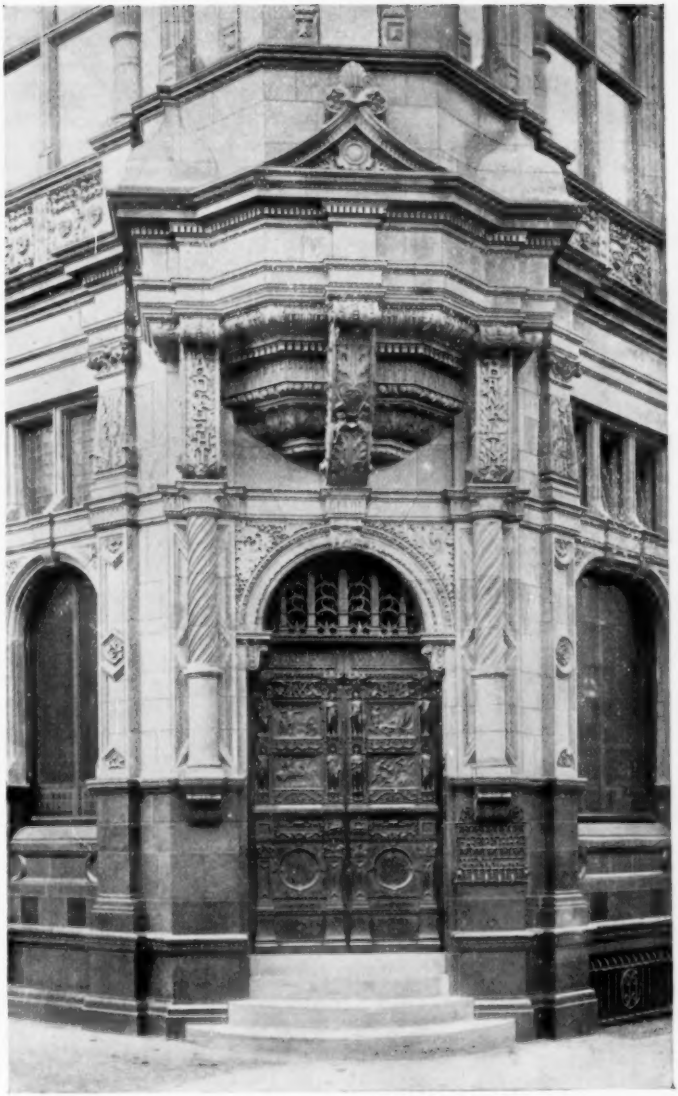
ST. CLARE'S CHURCH, SEFTON PARK, LIVERPOOL. BY MR. LEONARD STOKES.

an architect with a large practice among the Roman Catholic community, of which he is a member, is a true artist in architecture, whose designs always have a special interest both from their refinement of taste and from the variety of original treatment which they evince. Mr. Stokes belongs to an artistic family, his brother, Mr. Adrian Stokes, being one of the finest and most intellectual English landscape-painters of the day.

Among the younger architects who are doing good work, and of whom more will probably be heard, is Mr. W. D. Caröe, the new president of the Architectural Association. He has carried out designs both of Gothic and of classic tendencies, and has not so far developed a distinctive style of his own, but he has always put some original treatment into the employment of traditional details. Of this his Adelphi Bank at Liverpool, one angle of which is here illustrated, is a good example. The design of the bronze doors in this building, with their series of statuettes, has been much admired.

In the production of picturesques houses of small and medium size no one has been more successful than Mr. Ernest Newton, one of the "anti-Institute" architects. The variety of his houses, both in plan

BULLERS WOOD, CHISLEHURST—KENT. BY MR. ERNEST NEWTON.



ENTRANCE, ADELPHI BANK, LIVERPOOL. BY MR. W. D. CARÖE.

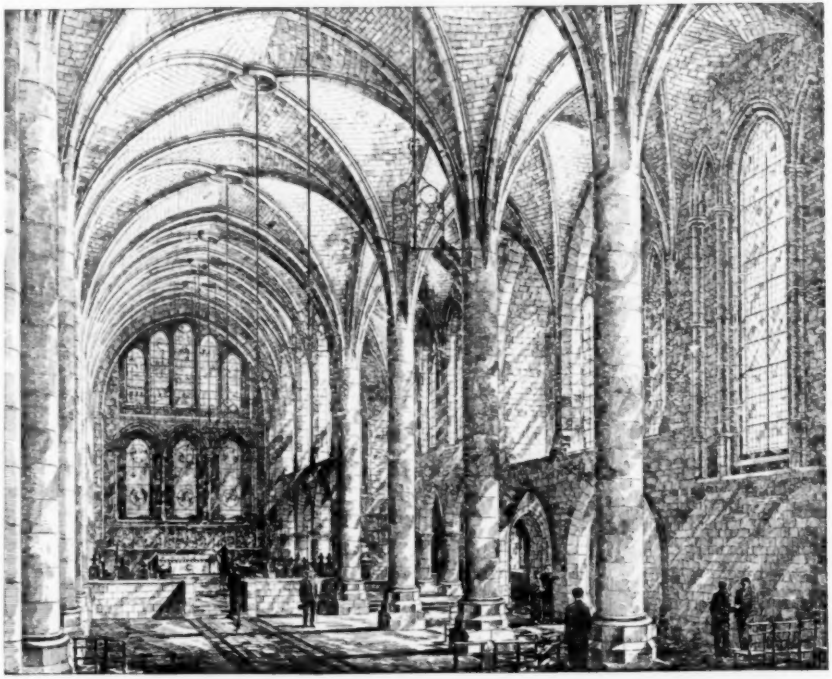
and design, is remarkable; what is more remarkable is the manner in which he contrives to give them picturesqueness of outline and effect without ever departing from simplicity. There is never any appearance of conscious striving after the picturesque, never anything vulgar or restless in appearance. If we compare his country houses with the terrible things which are shown at the French Salon under the term "maison de campagne," we can the better realize the good taste and reticence of this essentially English domestic architecture of Mr. Newton's.

An architect who has done comparatively little actual work, and who is regarded with great esteem from a conviction as to what he

STABLES, BECKLEY HALL,—KENT. BY MR. ERNEST NEWTON.

could do if he had the opportunity, is Mr. Halsey Ricardo, another of the clan who stand aloof from the Institute. There is a remarkable originality about the few things he is known by. His office front in Great George street (the street of engineers), where he has transformed a common brick front into a picturesque piece of street architecture by mere treatment of the windows and doorway, is a thing that no one can pass without notice. Another architect of original genius who has done little is Mr. Lethaby, the author of a recent notable book on "St. Sophia and Byzantine building," a designer of artistic furniture, an artist and draughtsman of remarkable powers, but who lives the life rather of a student of architecture than a practitioner of the art. Among the younger men of the day who will probably be more heard of is Mr. Beresford Pite, who jumped into note as a student from a remarkable, but somewhat *outré*, drawing, with which he gained the Soane medallion at the Institute of Architects about a dozen years ago, and was for some time known as a powerful draughtsman with a great fondness for medieval and Albrecht Dürer-ish effects, but is now showing that he adds to the eye of an architectural artist the practical insight of an architect. Mr. G. C. Hersley, a pupil (like Mr. Lethaby)

NEW TOWER, ST. MARY'S CHURCH, LYNTON. BY MR. H. WILSON.



CHURCH OF ALL HALLOWS, GOSPEL OAK, NEAR LONDON. BY MR. JAMES BROOKS.

FRONT OF OFFICES, GREAT GEORGE ST., REMODELLED FROM A PLAIN BRICK FRONT. BY MR. HALSEY RICARDO.

of Mr. Norman Shaw, is another beautiful draughtsman, who has made some very original designs, and who, if he develops a larger practice, will certainly produce buildings in which the art of architectural design will be worthily illustrated.

One more very clever architect must be mentioned among the younger generation, Mr. H. Wilson, formerly assistant to the late J. D. Sedding, and on whom the mantle and the practice of that talented architect has fallen. Mr. Wilson occupies a place entirely apart, having an almost visionary and utopian ambition to throw aside all precedent in architecture, and to produce buildings which are absolutely new in treatment. This, no doubt, has led him into a good deal of eccentricity, but it must be admitted that he has actually realized a remarkable originality in some of his designs, and, being possessed of exceptional powers as a water-color artist (at all events, in the treatment of architectural subjects), he is able to illustrate his own designs in a most effective manner, and his drawings are usually among the most striking and prominent exhibits in the architectural room at the Royal Academy.

The few illustrations which accompany this article serve only to give a very inadequate idea of the amount and variety of good, interesting, and refined architecture which is being produced by the best English contemporary architects. A more extended illustration would, I think, fully bear out what I have tried to impress on American readers in this article,—that, although the French may be superior to us in the grandiose treatment of large city buildings of more or less classic type, the English architecture of to-day is not inferior to that of any nation in the world in point of variety, picturesqueness, and refined taste, and that American students of architecture would do well to give it a little more of the attention which they at present seem disposed to bestow almost exclusively on Paris and the École des Beaux Arts.

THE PREVAILING SCARCITY OF SKILLED LABOR.

By A. E. Outerbridge, Jr.

Some one has well said that the tragedy of to-day is not the tragedy of the criminal, but of the incompetent, and not of the absolutely incompetent, but of the relatively incompetent. It is the tragedy of the man who has the best intentions and the best character and a fair equipment for his work, but who has not a thorough equipment, and who can not do the thing he starts to do in the best possible way. Society is crowded with half-equipped workers, with men and women who are honest and earnest and not incapable, but who are not up to the level of the very best work. It is amazing, in view of the immense number of those who are seeking for positions, how few persons there are competent to fill any particular position. To fill a position of any importance requires often most diligent searching in many directions. There is a host of fairly well-equipped people, but there seems to be, at the moment when they are needed, few perfectly-equipped persons. When one has a piece of work to be done, it is easy to get it fairly well done, but it is extremely difficult to get it thoroughly well done. This is true of all grades of labor. . . . In spite of the terrible need of work which weighs upon the masses of men, and in spite of the superior processes of education which are offered to the fortunate few, it remains true that society is filled with incapable or only partially-trained people, and that, when the thoroughly-trained man or woman, perfectly fitted to do a specific thing in a superior way, is needed, a candle must be lighted and a long search begun. The great lesson to be read to boys and girls to-day is the need of some kind of absolute competency, some kind of ultimate superiority.—*The Outlook.*

A RECENT advertisement for a "handy man" to fill the humble position of porter in a store resulted in blocking the highway with applicants, so that it became necessary to call a policeman to compel the men to form in line. Nearly all trades, not to mention one or two learned professions, were represented. At the same time the mechanical papers were calling attention in editorials and news items to the scarcity of skilled labor which has been observed since the revival of manufacturing business. What is the explanation of this anomalous or contradictory condition of affairs? It has been noted that, instead of a plethora of skilled labor seeking to take advantage of the newly-presented opportunities for remunerative employment, there is, in some trades, a prospective, if not already an actual, scarcity of such labor. It is surprising that a complete reversal of conditions should have occurred in so short a time, and various theories, more or less plausible, have been advanced to account for this change. It is explained, in a vague way, that the best men have drifted into "other occupations"; but, as it is a law of nature that two things cannot exist in the same place at the same time and two persons cannot fill the same position, this is no explanation, but a mere begging of the question.

We must either assume that one class of labor has been displaced by another class,—in which case there would still be a surplus of the unemployed,—or else that there has been a phenomenal enlargement of the field of occupations requiring skill. Everyone believes that there has been a large expansion and wide opening of new fields of labor through the aid of invention within a very few years, and especially in the domain of application of electricity to utilitarian purposes great activity now prevails; but, until this high pressure assumes a somewhat fixed point, and sufficient time has elapsed for the gathering of census returns, the ultimate effect of such new undertakings in affecting the labor market and in explaining the scarcity of skilled labor must necessarily be largely conjectural.

One fact, however, stands out prominently in this field of observation,—*viz.*, that the hysterical outcry of the Socialistic agitator (often echoed by misinformed, though well-meaning, philanthropists and theorists) that the introduction of labor-saving machinery would necessarily produce a permanent glut in the labor market is disproved by the present state of things.

No sooner have the wheels of industry commenced to revolve than it is found that the proportionate number of available skilled operatives has not kept pace with the increased number of mechanical appliances requiring such attention. In other words, the ratio of intellectual force to mechanical power formerly existing in the world has been changed through invention, and the equilibrium disturbed.

Every new machine put into operation demands at least occasional attention of skilled human labor. Each new invention widens the scope of human industry, opening up new sources of production and new outlets for consumption of manufactured products.

As new machines can be produced more rapidly than skilled operatives can be created, the balance between human skill to direct and mechanical power to execute,—between mental force and mechanical force,—heretofore existing, has been overturned, and, instead of a surplus of skilled labor crowded out by labor-saving machines, we find an opposite condition existing to-day. The demand for the modicum of skilled labor which the operation of all machines admittedly requires is greater than the supply, and to this cause I believe we may partly attribute the scarcity of skilled operatives which has been noted in some trades, especially those in which labor-saving machinery has been highly developed.

There are other causes operating to produce the same result, but I have endeavored to formulate one theory which has perhaps been hitherto overlooked. It will seem, no doubt, a contradictory and perhaps absurd statement to many readers that every new labor-saving inven-

tion increases the field for employment of skilled labor, but this anomalous proposition is advanced, not merely as a startling or a brilliant theory, but as a fact which has been demonstrated many times, as in the case of the sewing machine and other mechanical inventions. The statistics furnished by the Labor Bureau in Washington, though carefully shunned by many intelligent readers, afford a fund of surprising information, often upsetting the prognostications of theorists. Citations can be given *ad libitum* showing that, in many branches of industry in which the saving of labor has been most thoroughly accomplished, work is given to a much greater number of employees than could have been utilized without the increased business resulting directly from the decreased cost of production. "Everybody knows that ingenious machinery well nigh destroyed the once intricate trade of the carpenter, so that only the simplest operations remain to utilize manual labor. But the effect of this has been to increase the number of carpenters, not to diminish the demand. The ten years between 1880 and 1890 witnessed the introduction of many highly-efficient machines, by which hand labor was still further dispensed with; but, nevertheless, there were 140,021 carpenters in this country in 1890 against only 53,547 in 1880, and the average annual earnings in 1890 were $675 against $450 in 1880. Machinery for handling clay and molding bricks has made tremendous inroads upon hand labor during recent years; yet from 1880 to 1890 the number of persons employed in brick and tile making increased from 59,032 to 109,151, although the number of establishments increased only from 5631 to 5828 in the same period of time. . . . In few industries has the saving of labor by machinery been more marked than in the manufacture of furniture, and the cheapening of the product has been amazing. Yet this industry gave employment to 92,504 persons in 1890, as compared with 55,464 in 1880, and in the same period the average annual earnings of the employees advanced from $453 to $527.*

Such facts are irrefutable arguments, which agitators fear as greatly as dilettanti abhor. From a recent editorial discussion in the *Iron Age* concerning the scarcity of skilled workmen I quote as follows:

> It now appears to be absolutely necessary to devise further means of conducting manufacturing operations by labor-saving machinery, if the supply of workmen cannot in some way be augmented. Not only are skilled workmen scarce, but an absolute dearth exists of thoroughly-qualified experts to direct department work in large manufacturing establishments. Our mechanical progress appears to be developing at a rate of speed out of proportion to the conventional methods of preparing men to fill the exacting duties now required of them. Within the past few years new industries have grown at a marvelous rate, which have made heavy drafts on the ranks of those who either were, or were apparently destined to become, leaders in the older industries.

* From an editorial in "The Philadelphia Record."

Opportunities for more rapid advancement or for better financial returns have been seen in the electrical business, in the tin-plate trade, or in the manufacture of bicycles, or in some other comparatively new line. Again, the growth of old works has advanced men of ability in department work to positions of more general supervision, and vacancies have thus been created which are hard to fill.

With respect to the extent of the new and rapidly-increasing industry specified in the foregoing editorial,—*viz.*, the bicycle manufacture,—readers of the ENGINEERING MAGAZINE will recall a carefully-written and illustrated article in the issue for May, 1895, by Mr. Robert Perkins on this "Marvel of Mechanical Achievement." Mr. Perkins, who has been associated with the bicycle industry from its commencement in this country, states that he first saw a bicycle in 1869, and bought one in 1870 which weighed 116 lbs. At the cycle show in January, 1895, he saw a ridable machine weighing only 8¾ lbs., which safely carried a 160-lb. man on a floor, and he adds that, even at the roadster weight of 22 or 24 lbs., the cycle carries a greater load with safety than has ever been put on any other vehicle. After the temporary phase of the "high ordinary" had died out, the revival of the cycle in the United States began about 1882, but did not reach a popular craze until about 1890, since which time the revival has progressed with wonderful rapidity, which the hard times has never checked.

In England the present Coventry cycle industry employs about fifteen thousand hands in forty workshops. Mr. Perkins, in his article, estimated the output for 1895 in the United States at four hundred thousand wheels, and it is a well-known fact that it was not until last September that the majority of large manufacturers were able to catch up to their orders, from which fact it may be inferred that Mr. Perkins's estimate was below rather than above the mark. The average of a number of estimates based on figures obtained within a month gives the probable output for 1895 at 750,000 wheels. Statistics are not at hand to show the amount of capital invested and the number of skilled hands employed in this manufacture. Mr. Perkins hazarded the statement that perhaps a hundred millions of capital is employed in this industry in the United States alone, and recent announcements in the bicycle trade journals state that new capital has been enlisted to produce an enormously increased output of bicycles for 1896 at a great decrease of price.

To the labor employed in the direct manufacture of the bicycle proper, must be added that involved in the separate manufacture of adjuncts, such as rubber pneumatic tires, saddles, cyclometers, pedals, lamps, and the numerous articles known to the trade under the head of bicycle sundries, to the making of many of which separate manufactories are devoted. The impetus which this industry has given to invention

and improvement in the manufacture of cold-drawn light steel tubing, brazing, enamelling, nickel plating, and the manufacture of laminated wood rims has been comparatively recently demonstrated in a series of illustrated articles in the *Scientific American*. The use of this vehicle, not only as an instrument of recreation and sport, but as the business man's carrier, is not confined to the cities, but has penetrated even country districts throughout the entire United States, and the summer traveller is now surprised to find a high-grade wheel at almost every cottage in the villages. The necessity in many cases of being able to adjust and repair one's own machine is proving a silent mechanical instructor to many thousands of riders.

It is safe to assume that the near future has in store many new developments, such as a special package-delivery wheel, changeable gearing, motor wheels, &c., which will still further add to the natural increase in the manufacture and use of this wonderful machine. One of the illustrations in Mr. Perkins's article shows a large number of women employed in one or more of the departments of manufacture.

Some idea of the perfection of mechanical appliances used in the manufacture of bicycles may be gained from the fact that a large concern recently installed a hydraulic testing machine of the latest "Emery" design, having a capacity of 100,000 lbs., and has an equipment of tools equal to that of the finest government armories, while many elaborate special tools have been devised for this work.

Recent indications point to the probable development in the near future of the "Horseless Vehicle,"—a field which is at present unoccupied and almost unlimited. The successful long-distance trials of such conveyances in France (covering more than 700 miles in 2 days) have attracted world-wide attention, and American ingenuity is already at work upon the problem; even before the foreign tests were made, a carriage propelled by storage batteries was a familiar object on the streets of Philadelphia.

With the improvement of common roads, due in large measure to the influence of bicyclists, and the daily evidence afforded of the immense gain in speed and comfort of suburban travel by the substitution of electric trolleys for horses, it would seem natural to look for the general introduction of self-propelling vehicles; this would mean new employment for millions of capital and thousands of men.

It is but a few years since the first electric trolley street car line was established in Richmond, Va.; the comparatively small capital required was raised with difficulty, and so primitive were the appliances that for a few months it was not regarded seriously. It was customary on the approach of a storm to cut off all connection between the dynamos and trolley wire, tying up the cars and compelling the passengers

to walk home. A very few years ago a dynamo having an equivalent of 50 h. p. was christened a "Jumbo." Now dynamos of 5000 h. p. have been installed at Niagara Falls.

The trolley system, having spread a net work of wires like spiders' webs through every town of any importance, is now reaching out its feelers to connect the neighboring villages, and eventually to form trunk lines. Already announcements are made of business amalgamation of great manufacturers of electric and of locomotive machinery to exploit this promising field.

The guesses regarding the amount of capital invested and skilled labor employed in the development and manufacture of electrical appliances used in the trolley lines and for their equipment, and continuous operation, day and night, which sounded fairy-like when first announced, soon faded into insignificance when submitted to actual proofs.

The field of electric lighting alone, irrespective of power distribution, has grown to gigantic proportions, and, as statistics are now being gathered to exhibit these various new industries in their true proportions, it would be unwise to anticipate the publication of reliable facts by further guesses at this time.

A comparatively new industry which has sprung into importance within a few years, of the delicate nature of which the public has little conception, is the manufacture of the Welsbach incandescent filament for gas burners. Millions of these delicate filaments are now in practical use, and their manufacture, in which women are mainly employed, implies a high degree of skill. A new rival to the Welsbach light and the incandescent electric light has also recently appeared upon the scene in the form of the old and well-known acetylene gas, produced, however, by a new and cheap electrical process. Capital to a large amount has been attracted to the development of this discovery, and a new industry is apparently about to be created, the possible extent of which it is difficult to anticipate.

The improvements in the manufacture, and reduction in cost, of structural iron, following rapidly upon the modern practice of constructing "sky-scraper" buildings, some of them twenty stories in height, from a skeleton framework of iron, has practically developed a new industry of large magnitude. The utilization of rolled iron and steel for many other new purposes will no doubt still further enlarge this important branch of labor.

The manufacture of tin plate, which was commenced on a practical scale only a few years ago in this country, has thrived in spite of hard times and adverse tinkering of the tariff, so that the largest tin-plate mills in the world are now located in America, and turning out

finer tin plate by automatic machinery than was formerly produced in Wales by hand manipulation, the machinery being of recent American invention. The number of novel minor manufacturing industries which have originated in this country during the past decade is almost without limit, and in the aggregate they afford employment to armies of skilled operatives; among these, cash registers and cigarette machines are perhaps most remarkable. The chief examiner of the patent office recently stated that "the cash register has already put upon the market $15,000,000 or $20,000,000 worth of material, the cost of which is mainly labor."

A century ago hand-made watches were so costly that only wealthy people possessed them; the laboring classes depended on the town crier and the village clock. Now, the daily output of cheap but good machine-made watches from one factory in New England, is said to exceed the yearly production of the world a hundred years ago. Be this as it may, the number of hands employed in making watch making machinery far exceeds the total number of watchmakers before the invention of such machines.

In order to study our question with the hope of arriving at some understanding of the causes leading to this state of affairs, we should look first at the most obvious changes which have recently occurred in methods of conducting industrial works. Formerly master workmen were, as a rule, graduated apprentices, but the apprenticeship system has been gradually dying out in this country, and the reasons therefor are not hard to find. They may be classed under three heads.

First: The objection of the youth of to-day to binding himself to learn a trade, as was the custom of his forefathers.

Second: The restrictions put upon the apprenticeship system by labor unions.

Third: The modern "piece-work" system.

I find, upon inquiry among the working classes, many reasons given in explanation of the disinclination of boys to indenture themselves to day, the most frequent and important being the competition of labor-saving machinery. For example, in iron foundries small miscellaneous castings which are easily molded and require but little finishing were formerly made by boys, who soon became expert; an active, intelligent boy was able, in many cases, to make good wages long before the expiration of his indenture. Work of this kind is now generally made by molding machines, and I admit that the molding machine operates to the disadvantage of the apprentice. One molding machine will turn out more and better work per day than could be produced by the usual number of apprentice boys which a foundry could economically employ.

The intelligent boy who desires to acquire both theoretical and practical knowledge now prefers to enter the admirable industrial schools which are available in many of the larger cities ; the number of such schools, however, is, as yet, too small to provide facilities for more than a small fraction of one per cent. of the American youth. The work that these schools is accomplishing is of the highest order ; in fact, they are turning out a better class of graduates than was anticipated, and in this respect they are over-reaching the mark aimed at, which was to produce bright young workmen, not engineers ; men, not officers.

The arbitrary limiting of the number of apprentices in shops by trade unions was one of the short-sighted regulations made by that remnant of an old school of handicraftsmen, and is (in those occupations with which I am familiar) practically a dead letter.

The "piece-work system," which is superseding the old custom of paying workmen by time, or "day's wages," although stimulating the skilled hand to do more work and thus to receive more pay, incidentally operates against the employment of apprentices.

The skilled workman who has contracted to finish a certain "job" for a given price can not spare the time to assist a tyro. The apprentice is thus handicapped by such inventions as the molding machine at the bottom, and by the piece-work system at the top. The piece-work system is destined, I believe, to practically supersede time wages. Somewhat similar conditions confront the apprentice in the machine shop, and in fact in many other branches of industry. As the old system is thus clearly doomed, the wisdom of extensively enlarging the manual training school—not as a mere adjunct to the public school system, but as a distinct and important feature thereof—would seem to be clearly indicated, and it is hoped that the arguments here offered may emphasize this necessity of the times.

During the late period of depression, especially in the older established lines of manufacture, very many of the skilled workmen drifted gradually away from their former occupations into these younger and more active fields of labor, and, now that they are again required, are not available. This experience will prove a sober lesson to those employers who, from a short-sighted policy or economy, permitted their skilled operatives to depart on slight pretext ; and those, on the other hand (of whom there are many), who suffered actual losses rather than lose their skilled hands will now reap the benefit, not only in having facilities for prompt execution of orders, but in retaining the *entente cordiale* of their employees, which is an important item in economic administration. There is no service like willing and interested service.

One of the largest manufacturers in the world said not long ago in reference to this matter: "It is simply impossible to put new men into the places of our trained workmen, for it takes years to learn the business. Throughout my whole business career I have made it a rule to stand by my trained workmen to the last limit of endurance; and, whenever we had a difference, and I felt myself to be right in the position I took, I simply shut down the works until they came to my point of view." This is a correct principle upon which to conduct a manufacturing establishment, and, if generally followed, would soon become an established custom.

The introduction of labor-saving machinery has enormously increased the output for each workman, and this introduces a new element into the ethics of the question of wages, and also into the practical question of cost. If it can be shown that a skilled workman, at a slight increase of labor and attention, can enormously increase the output of a machine, he should be encouraged to make the effort by an increase of pay; an increase of output must logically and necessarily involve a corresponding and fair increase in wages. Hence increase of output necessitates increase of wages, and in a properly-conducted business this increase of wages, following increased output, must mean increased profit. This is a profit-sharing scheme to which there can be no practical objection.

The conclusions to which the foregoing arguments clearly lead are: that high wages and intelligent service are to be preferred to low wages and ignorant labor; that the introduction of labor-saving machinery, instead of supplanting human skilled labor, has increased the demand; that the more highly developed the machine becomes, the more highly skilled the operative must become; that there is an ever increasing demand for skilled labor of the highest class and a constantly decreasing chance for mediocrity to find employment; and that this supply must come, not, as heretofore, mainly from training boys in factories, but from the enlargement of manual training schools, whose teachers shall be practical graduates from the factories.

The introduction of machinery in place of hand labor in manufactures is thus shown, from whatever point of view it is studied, to be mutually beneficial to the employer, the employee, and the consumer,—that is, mankind in general.

THE DISTRIBUTION OF POWER IN COLLIERIES.

By Llewelyn B. Atkinson.

THE present position of the coal-mining industry in the United Kingdom is one deserving of the most thoughtful consideration by all who are interested in the future of the commerce of the country, and the object of the present paper is to point out how, possibly, some of the difficulties under which this industry at present labors may be met. The difficulty to be contended with may be briefly stated. The possible output, and, indeed, the output at which a reasonable profit can be earned, is greater than the demand at present prices; and even this demand is threatened by the decreasing price of coal raised in other countries. From whatever point of view it is looked at, this question resolves itself into stimulating demand, which can be effectually done only by lowering the selling price, and this cannot at present be done without extinguishing the profit. To decrease the cost at the collieries, there are broadly three courses: (1) to decrease the payment per ton to the mineral owner; (2) to decrease the wages cost per ton raised; (3) to decrease the fuel expenditure per ton raised. The first of these is a matter outside the scope of this paper, the second will be briefly touched upon, and the third will be dealt with in some detail.

In the course of the last 8 or 9 years, the author has been in close contact with mining operations in various parts of England and Wales, and the opinion has gradually been forced upon him that there is a very large margin of economy in wages and fuel to be effected. This arises from the fact that economies in labor and fuel which are studied and made use of in engineering and manufacturing industries are hardly considered in coal mining, at all events in the majority of instances. This broad fact must appeal to every mind,—that, whereas in almost every manufacturing process, or industrial operation, the product per man has probably doubled and the consumption of fuel been halved within the last 15 years, in coal mining the product per man has been practically stationary, and the cost of fuel per ton raised probably nearly so. This is frequently attributed to the stringency of mining legislation, but legislation has also largely affected other industries, and the result cannot be altogether attributed to this cause. It would be a long task to enumerate the causes which, in the author's opinion, contribute to this result; but, broadly, it ap-

pears to him that what is required is to do in mining what has been done in every other department of industry,—lower the cost of wages and material per ton by increasing the product per man and per pound of fuel by the following means: (1) improved organization, both in the working, and more especially in the original laying-out of the scheme of working a colliery, and in the means for doing it; (2) more superintendence and supervision underground by thoroughly well-informed mining and mechanical engineers; (3) the greater use of mechanical power instead of human and horse labor, and more economical production of that power. In short, substitute brains and mechanical power for human labor.

It has been already stated that the immediate object of this paper is to deal with the question of the economical production of power, but a few remarks on the subject of mechanical power in collieries may be useful. The getting of coal resolves itself into cutting and filling and hauling to the pit bottom. In the great majority of collieries both cutting and filling are done without any use of mechanical power whatever, and the progress made in introducing mechanical coal-cutters is slow, at all events in this country. A considerable experience, extending over some years, with coal-cutting machines in various collieries and various parts of the country justifies the author in saying that there are hardly any seams under 3 ft. 6 in. in thickness that could not be more cheaply worked by mechanical coal-cutters than by hand labor, and with a better product of round coal, but that in probably not 5 per cent. of the collieries of the country is the existing organization of the filling and haulage sufficiently good to enable machines to be worked with that regularity which will make them pay. This is the secret of the otherwise unexplained fact that some few collieries have been and are worked by machinery with marked success, whilst the reverse holds good of the majority of cases in which it has been tried. Organization and superintendence, those are the only secrets of cutting coal by machinery; till they are forthcoming, mechanical assistance in this direction must be postponed. In thin seams much might, no doubt, be done to apply mechanical power to reduce labor and breakage in filling the coal, but the same remark applies as to coal-cutting. The use of machinery in the coal face would so much reduce the length of face under work for a given output that the roads on to the face—being less in total length—could, without increased cost, be kept in a condition enabling mechanical haulage to be used right up to the face, doing away with horses and ponies altogether. These are some of the directions in which mechanical power may be looked for to profitably enable the output per man to be increased. But before this can be done much will have to

be done to improve the general organization both above and below ground. And this may well be commenced by the economical laying out and conduct of the arrangements for the generation of power above ground. Consider the conditions under which this is at present carried out.

Generally speaking, when sinking operations are completed, a winding engine is put down. Subsequently, as the workings extend, haulage is considered, and some plant—either steam, compressed air, or electrical—is provided for this. Later perhaps pumping becomes necessary, and again a plant perhaps on another system is put in. There are various engines at the surface for the screening, repairing shop, and other purposes. All these are of uneconomical types; so there ensues, at every point, waste of heat and waste of steam, particularly when, as in some cases, separate boilers are put down for each plant. And the answer to any criticism generally takes the form: "Oh, fuel is so cheap at a colliery that it does not matter." Why is the fuel so cheap,—that is, of such low value? Because it is so small —smashed in hewing, smashed in filling, smashed on the screens, due to imperfect methods and appliances at every point. But, at any rate, it is worth at least 2s. 6d. per ton, and it is estimated that from 5 per cent. up to even 10 per cent. of the total output by weight of the collieries is consumed at the surface, and this means, even taking the lower figure, about 9,500,000 tons, worth about £1,190,000 per annum. It has been stated by Mr. Forster Brown that the probable consumption of coal in colliery engines, taking an average, would be not less than 6 lbs. per horse-power hour. Taking this to refer to indicated horse-power, it is possible to produce the same power with 1½ lbs. of coal, or even less; hence it may be fairly said that there is a possible saving to be effected of 75 per cent., worth annually nearly £900,000. It would probably be well within the mark to say that the saving to be effected in labor of handling, and in the maintenance of boilers and appliances for consuming this, would be worth, say, 65 per cent. of the above sum, showing a possible economy of, say, £1,500,000 per annum, a sum equal to over 2 per cent. on the total value of the coal raised, or about 3¾ per cent. of the whole wages annually paid in the mining industries; and, if the coal were raised unbroken, so that its value was equal to the average value of the coal sold, these figures would rise to 3 per cent. of the value of the total coal raised, or 6 per cent. of the wages paid. It may be stated at once that, to realize these economies, the power required must be produced by compound or triple expansion condensing engines, appliances almost unknown in colliery work, and to do this there is no doubt that the question resolves itself into the production of the whole

power required at the colliery in one or at most two engines, and its distribution with as little loss as possible to the points where power is required. There are various methods of distributing power, but some of them are applicable only to particular cases, or in particular circumstances; the only two of general applicability are compressed air and electricity. Of these, while under favorable circumstances compressed air can be made to give a favorable efficiency, its application in mining is discounted by two important considerations of economy. To utilize compressed air with efficiency (1) the pipes must be free from leakage, (2) the air must be heated before being used. These two conditions are practically unrealizable, and hence the efficiency of air transmission in collieries is, and must necessarily be, low. The cost of plant and extended air-mains is also high. There is an advantage in compressed air that to some extent it admits of storage, and therefore the power-producing plant may be fully loaded, producing the average requirement, which, as will be presently shown, is considerably less than the maximum. With this one exception of storage, the advantage in point of view of efficiency as a means of distributing electric-motive power remains with electricity; and the economy of the cables compared with air mains, and the facility for extension and alterations in the position of the machinery, make electricity an ideal means of distributing power.

There is, however, an objection to which I must refer,—*viz.*, the question of safety. This question of safety is one which, from the first introduction of electricity in mining, has been prominently before engineers; but it may be noted that among those who have had practical experience of its use in mines the objection is rarely raised. In a paper read in 1891 before the Institution of Civil Engineers by the author, in conjunction with Mr. C. W. Atkinson, this question was somewhat fully dealt with, and certain conclusions were arrived at which time and experience have gone to prove the correctness of; but, as this question is to some minds still an open one, and as additional experience has added to the knowledge of the subject, it may be well to deal with it at some length. There are two distinct questions: (1) the safety of an electric motor, which may spark at the commutator; (2) the safety of a system of cables, which may be ruptured while carrying an electric current.

Dealing with the first of these, it has been shown from various considerations and by practical tests that with the amount of sparking which exists with electric motors of good construction it is impossible to ignite firedamp, owing to the fact that the temperature is never sufficiently high, and it is only therefore in exceptionally abnormal circumstances, such as a brush falling out of its holder, or becoming

displaced absolutely on the commutator, that the inflammation of firedamp can be effected ; and it has also been shown conclusively by experiment that there are in the market methods of enclosing either the whole machine, or the armature and commutator, or the commutator alone, which, even under these abnormal circumstances, entirely prevent either the access of firedamp or the ignition of firedamp outside the machine. Practical experience is in accord with experiment and with the principles named, and the author knows of no recorded instance where there has been any accident from the use of an electric motor in a coal mine. As regards the second point in the question of safety,—*viz.*, the possible breakage of a cable,—this may be at once overcome if the cables are buried below the surface ; but, as this method has the disadvantage of expense, and frequently of deterioration of the cable, we may consider the case of a cable hung from the walls or timbers. In this case, if the cable does break, the ends are quickly parted ; the spark may continue for the fraction of a second, but it has been shown by the experiments of Messrs. Wüllner and Lehmann, at Aix-la-Chapelle, which experiments were accepted by the Prussian Firedamp Commission, "that even violent sparks from rupture of the current, accompanied with the explosion of fragments of iron in a state of combustion, had no effect on the inflammation of firedamp."

Considerable light has, in the author's opinion, been thrown on this question by the facts recently stated by Professor Vivian B. Lewes. It appears that the ignition of firedamp arises in most cases, not from the raising of the temperature to the ignition point of firedamp, which is very high, but by the raising of it to the point of its decomposition with evolution of hydrogen, which, becoming ignited, eventually ignites the firedamp. This requires two things: (1) Time (and Professor V. Lewes states that 10 seconds is in some cases necessary); (2) the maintaining of a particular mass of gas in contact with the point where the heat is developed long enough to effect the operation quoted. Neither at the commutator of a motor, or in the case of a ruptured cable, are these conditions fulfilled. In the face of the facts and experiments and experience now at disposal, in the author's opinion, those who raise the objection to electricity in mining on the ground of safety ought to bring some proofs of that danger, if it is to receive consideration. Notwithstanding the extended use of electricity, these accidents do not occur, and, in the opinion of many well qualified to give it, the danger arising from electricity is less than that arising from safety lamps, and enormously less than that arising from almost any explosive agent now in daily use.

Having dealt with this question, it remains to be asked: Is the

present position of power distribution by electricity such that we may use it with confidence for the whole of a power required at a colliery? The author's answer to this is, yes. In support of this may be given the following facts. The largest engine at a colliery is the winding engine, and, supposing this to require to be capable of developing power at full speed of 1000 h. p., which is an outside figure, this could be well replaced by two motors of 500 h. p., one on each end of the shaft of the drum, without gearing. There are numerous cases of dynamos and motors of this power working with ease and satisfaction and giving no difficulty whatever, and operated by ordinary mechanics with no more trouble than an ordinary steam engine.

Motors of smaller sizes are in use all over the world, and with universal satisfaction as to ease of manipulation and low cost of maintenance. Are the claims made for efficiency of electric distribution of power realized? On this point the author has examined carefully tests made by himself and by others on electric-power plants, and has arrived at this conclusion: while the efficiency of distributing electric power and its utilization in the motors come up to that claimed, the efficiency of the production of electricity is not, as a rule, as high as is claimed, or as high as may be realized. The reason is this: sufficient account is not taken of the fact that the average load is considerably less than the maximum requirement, and the curve given, which is taken from an actual test of a direct-coupled engine and dynamo, will show how this operates. While the efficiency of electric generation—that is, the proportion between the electric power delivered to the cables and the indicated horse power of the engine—is as high as 86 per cent. at full load, it falls to 74 per cent. at half load and to about 58 per cent. at one-quarter load. The reason for this is to be found in the power the engine takes to drive itself. The engine is generally arranged to work with an economical cut-off at the full load or maximum power, and consequently is larger than necessary for all smaller loads. It should be arranged to work with an economical cut-off at the average power; then at a larger power, although the consumption of steam per indicated horse power would be somewhat larger, the mechanical efficiency would be so much better at the average load that considerable economy, and, indeed, the best possible result, would be obtained. The moral is to use engines with automatic expansion valves, permitting the engine, if a simple one, to work with a cut-off as late as one-half or five-eighths of the stroke when developing the maximum power, and working with a more economical grade of expansion at the average load.

To apply the principles advocated in this paper, the method to be adopted should be as follows: when a colliery is opened, an estimate

must be made of the power which will ultimately be required for the whole colliery. It need not be all provided for at once, but the arrangements must be such that what is provided will be worked at an economical load, and that by simple duplication it may be increased. Suppose an example is taken which may be considered to represent an average case, where there is no very heavy pumping.

TABLE OF POWER REQUIRED AT A COLLIERY.

	Maximum power. Horse-power.	Average power. Horse-power.	Minimum power. Horse-power.
Winding	700	225	0
Fan engine	60	60	60
Pumps (say)	50	50	50
Haulage	200	100	0
Lighting	20	10	10
Screens	20	20	20
Shops at surface	20	5	5
Capstans for wagon handling	20	10	10
Total	1090	480	155

The power required by the winding and haulage engines are what would probably be required in a colliery drawing about 1500 tons per day, and the maximum power required by the winding engine is reckoned on the assumption that the weight of the ropes is unbalanced, and the average upon the assumption that the winding takes 40 seconds, and the unloading and loading 25 seconds. Variations will correspondingly affect these points, and must be made to suit each case. These powers are those required at the separate machines, and, if we take it that the loss in the cables at full load is 5 per cent., which will be ample, as the bulk of the power is not far from the source, and that at the average load and upwards the indicated power is as shown on the curve (steam dynamo efficiency),—that is, $\frac{100}{86}$ of the power delivered to the cables,—we get the following as the indicated power required at each load, which, assuming that the electric motor will transform only as much electric power into mechanical power as a steam engine would convert of indicated power into mechanical power, gives a direct comparison between the actual indicated power required if all the engines were worked direct from the boiler or by the distribution thus to be effected.

INDICATED HORSE-POWER OF GENERATING ENGINES.

Maximum. Average. Minimum.

$$\frac{100}{86} \times \frac{100}{95} \times 1090; \quad \frac{100}{86} \times \frac{100}{97.5} \times 480; \quad \frac{100}{64} \times \frac{100}{95} \times 155$$

$$= 1330 \qquad = 572 \qquad = 255$$

Now, it will be observed that the average power is 572 indicated horse power, as compared with 480 indicated horse-power actually required at the engines. But taking for the former Mr. Forster

Brown's figure of 6 lbs., and for the latter 1½ lbs., the economy resulting is found from the fraction:

$$\frac{6}{15. \times \frac{528}{480}} \text{ or } \frac{6}{1.78} \text{ or } \frac{100}{9.6}$$

not far differing from the possible economy spoken of early in the paper. That such figures are realizable in practice is shown by the figures given in a paper read before the North of England Institute of Mining Engineers by Mr. Alexander Siemens. Tests are there recorded where, with a plant considerably smaller than that here considered, a consumption of 2.62 lbs. per e.h.p. hour, equivalent to 2.25 lbs. per indicated horse-power hour, was obtained; and in the discussion on the same paper reference was made by Mr. D. B. Morison to a plant using 2 lbs. coal per e.h.p., equivalent to 1.72 lbs. per indicated horse-power. The use of triple-expansion instead of compound engines would further reduce this to the figures named above.

The writer is aware that in thus advocating the generation of the whole of the power in one engine or pair of engines he is advising a very radical departure from existing and well-tried methods; but the advantage in economy is so great that, in his view, a revision of method must take place, and in any case the subject is well worthy of consideration and discussion.

THE GREAT EASTERN. LARGEST STEAMSHIP EVER CONSTRUCTED, 1859.

Had paddle-wheel and screw engines; 10 boilers; iron hull; length 680 feet; tonnage 32,160.

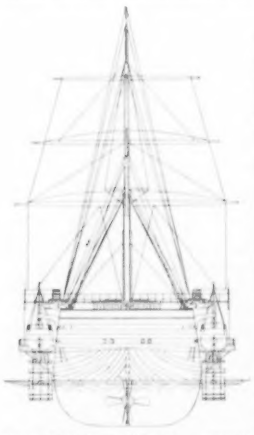
THE TRANSATLANTIC STEAMERS OF 1856 TO 1880.

By Samuel Ward Stanton.

WHEN, in 1852, the steamship Australian began running on the mail line between England and Australia, it was found that, on account of the expense attached to supplying coal depots at certain points on the route (the steamer being unable to carry enough fuel to make a straight voyage), the round trip caused a loss of from £1000 to £10,000, even when the vessel carried a full cargo and complement of passengers. On her first trip the Australian was 221 days in making the round voyage, 165 of which had been steaming days at sea, the other 56 being passed in port. The coal at the different points at which she stopped had been previously sent out in sailing vessels for her use exclusively. With this experience in mind a company was formed in England in 1853-4 to construct a vessel large enough to carry all the fuel she might need in a voyage from England to Australia and back, and to steam at the rate of 18 miles an hour. Accordingly the noted engineer Brunel designed a vessel of enormous proportions, and a company, known as the Eastern Steam Navigation Company, was organized, the capital of which was £1,200,000, in shares of £20 each, with power to increase the same to £2,000,000. The money was soon subscribed, and on May 1, 1854, the first plate of the Great Eastern was laid in the yard of J. Scott Russell & Co., at Millwall-on-the-Thames.

The hull of the Great Eastern was double-built,—that is, she was constructed with an inner and an outer skin, these being placed 2 ft. 10 in. apart, with longitudinal webs at intervals of 6 ft. running the whole length of the vessel, these being subdivided by transverse plates into water-tight spaces of about 6 ft. square, thus insuring safety should the outer part of the iron hull become fractured. Many steamers are now built on this principle, notably those of the Fall River Line, running on Long Island sound. The hull of the Great Eastern was divided by transverse bulkheads into twelve water-tight compartments below the lower deck, and nine above the lower deck, and it was contended that two of these compartments might be filled with water without danger to the ship. In addition to these transverse bulkheads, there were two which extended from the bottom of the ship to the upper deck, running longitudinally for a length of 350 ft. There was no keel, the bottom being flat, and in shape below the water line

she was quite similar to fast Hudson River boats of the period, having very fine lines and a long, sharp bow. The iron plates of the hull were ¾ in. in thickness, while the plates forming the keel were 1 in. thick. The average size of the plates, of which there were thirty thousand, was 10 ft. by 2 ft. 9 in. About 8000 tons of iron were used in the construction of the hull.



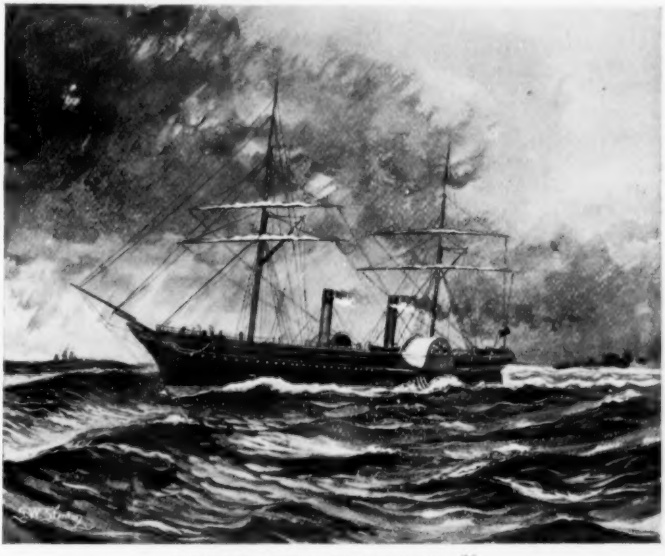
THE GREAT EASTERN. STERN ELEVATION.

There were six masts, two square-rigged and others carrying fore and aft sails only, the larger masts being iron tubes and the smaller of wood. The funnels were double, the space between the inner and outer skin being intended to hold water. She was the first English steamship built without the proverbial bowsprit and figure head,—a style that was copied from American steamers. Though the Great Eastern was intended for the Australian trade, she never made a trip to that place. Her first trip was made from Liverpool to New York, where she arrived on June 28, 1860, the greatest speed attained during the passage being 14½ knots an hour. The distance run was 3188 miles, and her greatest day's steaming was 333 miles. The total consumption of coal was 2877 tons.

At the time the Great Eastern came out, an ocean voyage was an undertaking which only the hardiest of sailors—those used to the sea—cared to indulge in; only those who were obliged to go on business embarked without much contemplation; all others weighed the matter carefully, giving much thought before making up their minds to trust themselves on board of one of the steamers of the time, which often came into port bearing the marks of the terrible shaking up they had received from old ocean. And the passage of from 10 to 15 days in the stuffy, ill-ventilated cabins was an experience which few cared to indulge in often. But with the advent of the Great Eastern these discomforts were over, in a measure, for she was a vessel of such stupendous size that the elements affected her comparatively little. The following is taken from an account written by a passenger on her first trip:

I still found it blowing very hard, and the sea covered with a thread-like foam, which filled the hollows as well as whitened on the billow tops. Still, the ship rolled only eight degrees, and her stately nod did not disturb a plate upon the table. The storm-rack was laid at breakfast to protect the dishes, but it was not needed, for my

full tea-cup sat outside of it without being in the slightest peril of a slip. Nevertheless a 3000-ton ship would have been pitching sadly. The motion did not succeed in making a single person sea-sick, though there were among her passengers several who had never been to sea before. The wind moderated still more during the afternoon, and we set all our topsails. . . . Nothing could be more beautiful than to stand upon an elevated grating in her bow and see her stern lift itself majestically against the sky as we dropped into some yielding wave before us, or to behold her rising sideways to her equilibrium. . . . I could hardly realize, as I viewed her buoyant step upon the deep, that ten thousand plates of iron, representing 12,000 tons of inert metal, clamped by three million rivets, and bearing within, besides her ponderous engines, 6000 tons of coal, could career thus, cork-like, upon the bosom of the thin and shifting element below. . . . The most striking idea of her size, however, and the greatest demand upon your wonder that she swims so lightly, is obtained by going down by her sponsons, outside and aft the paddle-boxes, which enables you to see her entire towering section abaft the wheel. From that point you face up and down her massive sides and see the black warehouse—for it does not look like a ship —grandly rise and fall in the hissing and downy foam which the wheels send flying by her run. . . . It is only when in comparison with some other object that the



STEAMSHIP SCOTIA, CUNARD LINE, 1862.

Last British Transatlantic Paddle Steamship. Length 379 feet; tonnage 3871.

Great Eastern sensibly exhibits her huge proportions to an accustomed eye, and then everything else is dwarfed by her neighborhood.

During the following 3 years she made a number of trips to New York, but, owing to a lack of freight at profitable rates, she was a

ANCHOR LINE STEAMSHIP, DEVONIA, 1877.

Length 500 feet; tonnage 4269.

constant source of loss to her owners. She was destined, however, to perform one of the greatest feats that had ever been consummated for the benefit of mankind, and this was the laying of the Atlantic cable in 1866. A previous attempt had been made, in 1865, but the cable broke in mid-ocean. The British government used her occasionally as a transport. In 1867 she was again fitted up, at great expense, to ply between England and New York. She made one trip, and on her return was seized at the instigation of the seamen, who claimed unpaid wages. When this matter was adjusted, she was leased for cable-laying purposes, and in 1869 laid the French Atlantic cable. She then went to the Persian Gulf and laid the cable from Bombay to Suez, in 1870, and in 1873 and 1874 laid the fourth and fifth Atlantic cables, and afterward laid other cables. She has only lately been broken up on the banks of the Mersey. For dimension details see page 260.

The last and the grandest of the paddle-wheel steamships built for the Cunard Line was the Scotia, which came out in 1862. She was almost identical in all respects to the Persia of 1855, although her lines were finer and she possessed greater power. These two steamers were unquestionably the handsomest paddle steamers that ever ran across the Atlantic, and from a marine point of view were as perfect

and graceful as it would be possible to make a paddle steamer designed for ocean service. The New York *World* of May 11, 1876, contained the following:

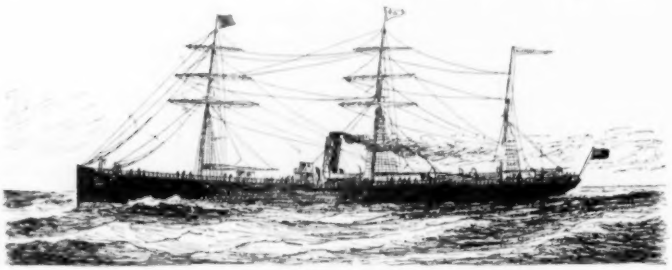
> The oldest and the newest of the great ships of the Cunard Line – the Scotia and the Scythia – arrived together yesterday, bringing, between them, more than three hundred cabin passengers. The arrival of the Scotia may be regarded as, in its way, a "Centennial" event, that stout old paddle-wheeler having been withdrawn some time ago from the line, and put on again chiefly, we believe, to accommodate the special centennial passengers of the year.

Thus, in a dozen years, the Scotia had been relegated to a back place in the transatlantic fleet, although as stanch a vessel as the newest of them, and of great power and excellent speed. But the march of improvement had continued, and the unwieldy paddles were superseded by the more compact screw, the new type of engine furnishing as great power with much less consumption of fuel. The Scotia burned an enormous amount of coal when compared to the modern screw steamers, and so, when the British Telegraph Construction and Maintenance Company purchased her in 1879, after she had been laid up in England, her paddle engines were removed and twin screw machinery was placed in her, since which time she has done valuable service, her hull being almost as stanch and showing its beautiful lines as well as when first launched.

Following the Scotia, all new steamers built by the Cunard Line for the transatlantic trade were supplied with screws, and the same year that this famous vessel appeared the screw steamship China was built, which was eminently successful. The Cuba, Java, Russia, Abyssinia, Algeria, Bothnia, Scythia, and others, came after, the line continuing to be one of the leading companies operating upon the Atlantic.

Messrs. Handyside and Henderson, in the year 1856, refitted the sailing vessels Tempest and John Bell, placing in them propeller engines, and with another steamer, the Inez de Castro, inaugurated the well-known Anchor Line, the route of which was from Glasgow to New York; previous to this year they had been running sailing vessels between Glasgow and the Mediterranean, and this route was also continued. The line received no aid from the government, but with good management soon became of importance. By 1880 twenty-three steamships had been constructed for the Atlantic service, and more than thirty for Mediterranean trade.

The Hamburg-American Line, established in 1847 as a line of sailing packets, in 1853 ordered its first steamers, the Borussia and Hammonia, the former beginning the regular service between Hamburg and New York in 1856 and making the trip in 14 to 15 days. The



ANCHOR LINE STEAMSHIP, CALIFORNIA, 1872.

Length 361 feet, tonnage 3410.

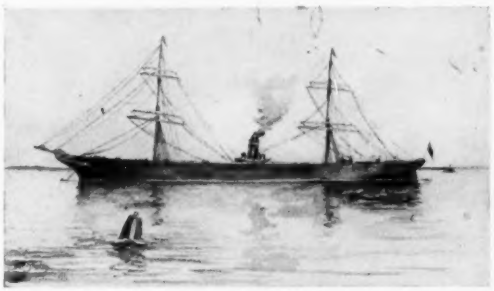
North German Lloyd started its line from Bremen in 1858 with the steamers Bremen, New York, Hudson, and Weser. The Glasgow Line of steamers to New York, consisting of three boats, was discontinued in 1859, owing to poor business and the loss of the steamship New York. The French Line between New York and Havre was started in 1862. In 1863 the National Steam Navigation was established, in Liverpool, and three steamers, the Louisiana, Virginia,

ANCHOR LINE STEAMSHIP, ANCHORIA, 1874.

Length 408 feet; tonnage 4168.

and Pennsylvania, were placed on the route from that port to New York. The next year the line was reorganized and became known as the National Steamship Company, and has since been identified with steam navigation across the Atlantic. The Italy, built in 1870, was the first Atlantic steamship fitted with compound engines, and may be considered an important vessel.

Following the National Line, the next transatlantic company organized was the well-known Guion Line, which commenced operations in 1866, the first steamer being the Manhattan, a fine ship. She was followed by the Chicago, Minnesota, Nevada, Idaho, Wyoming, Wisconsin, etc. The two latter vessels were among the first steamships to have compound engines.

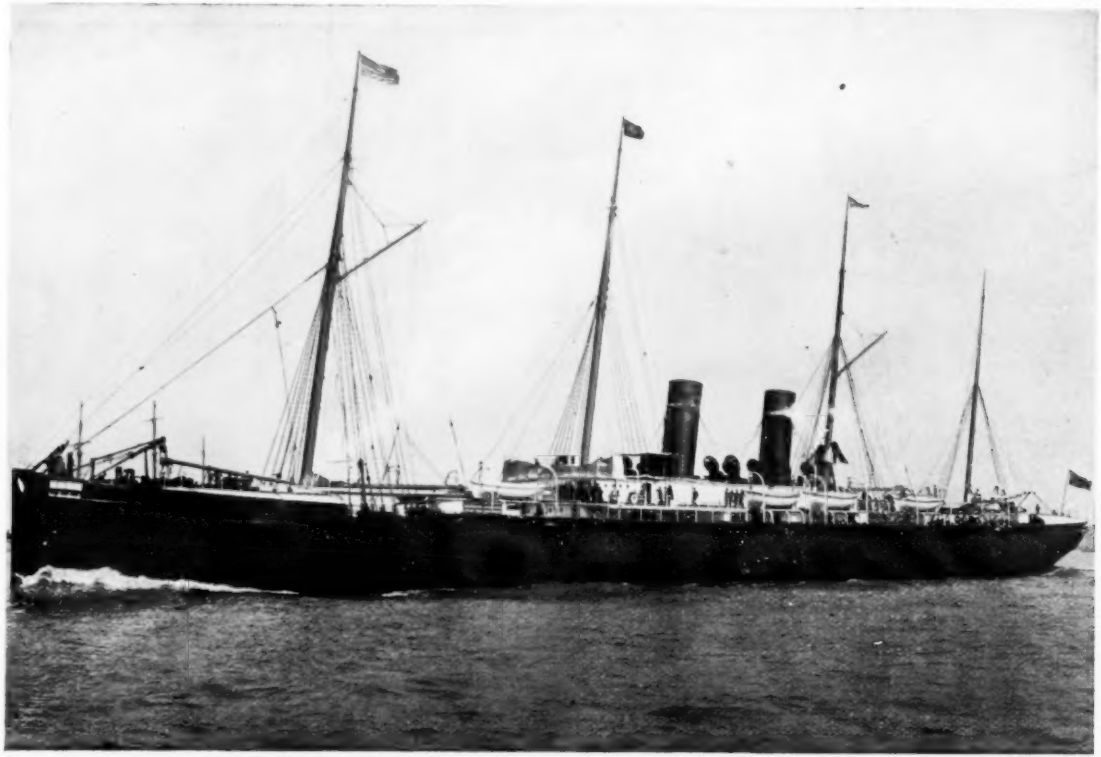


STEAMSHIP MANHATTAN. FIRST STEAMER OF THE GUION LINE, 1866.

Length 335 feet; tonnage 2869.

In 1866 Messrs. Ruger Brothers, of New York, with associates, started the North American Lloyds, which company purchased the steamers Atlantic, Baltic, and Western Metropolis, and chartered the Ericsson, Merrimack, Mississippi, and Northern Light, running them between New York and Bremen, touching at Southampton both ways. The line was unsuccessful, and in 1867, in connection with other parties, the New York & Bremen Steamship Company was formed. The Atlantic, Baltic, and Western Metropolis were taken over, the Northern Light was chartered, and these four steamers plied between New York and Bremen, but with no better results. In 1868 Messrs. Ruger chartered the Arago, Ariel, Circassian, Northern Light, and Quaker City, and ran them between New York and Bremen, but the field was finally abandoned to the North-German Lloyds. In 1869 the Messrs. Ruger chartered the steamers Ariel, Fulton, Guiding Star, Northern Light, and Santiago de Cuba, placing them on the route to and from New York, Stettin, Copenhagen, and Christiansand; they also chartered the Ocean Queen and Rising Star in 1870; but the line did not pay and was abandoned.

The famous White Star Line, one of the best known of the Atlan-



GUION LINE STEAMSHIP, ARIZONA, 1879. LENGTH 464 FEET; TONNAGE 5164; FASTEST ON THE ATLANTIC WHEN SHE APPEARED.

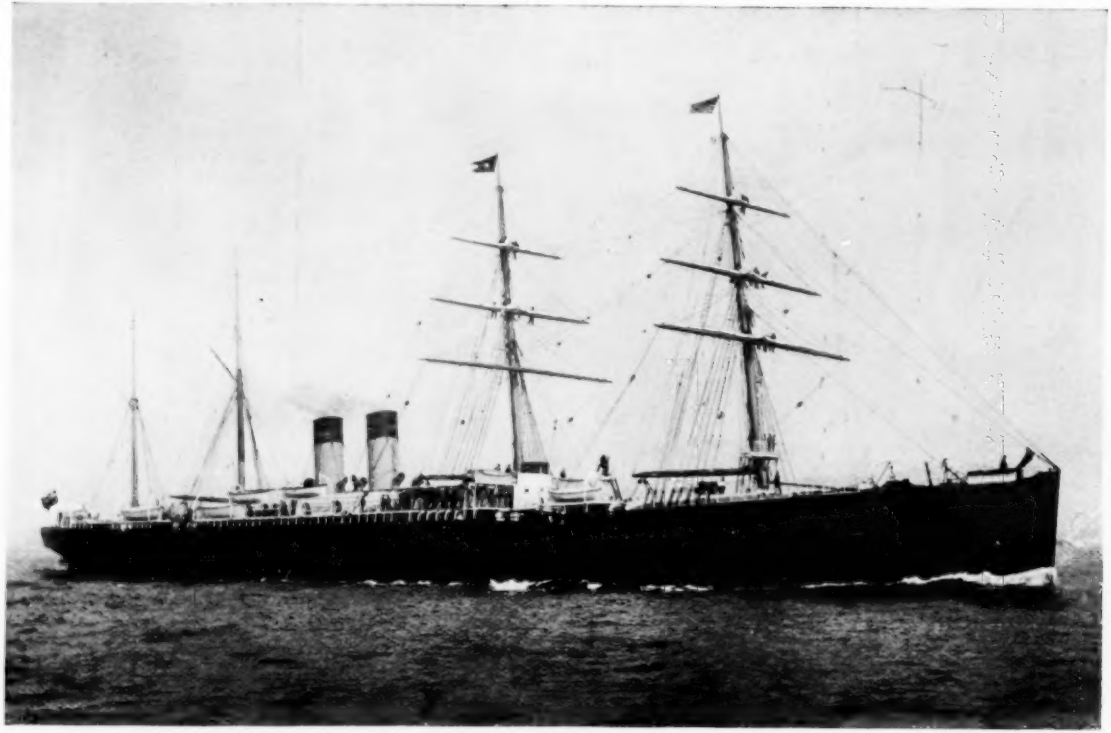
tic lines of the present day, was at one time composed of sailing packets which plied between England and Australia, over 40 years ago, in the course of 7 years conveying about half a million adventurers to the gold fields. In 1867 an important change took place; the managing owner retired, and the flag was taken over by Mr. Thomas Henry Ismay, who began by introducing iron ships instead of the wooden clippers then in use. In 1869 Mr. Ismay established the Oceanic Steam Navigation Company, Limited, and the advent of its first steamer, the Oceanic, in 1870, may be said to have marked an epoch in the annals of passenger travel on the ocean. Instead of having the saloon and state-rooms in the after part of the vessel, this boat

THE PIONEER OF THE WHITE STAR LINE, STEAMSHIP OCEANIC, 1871.

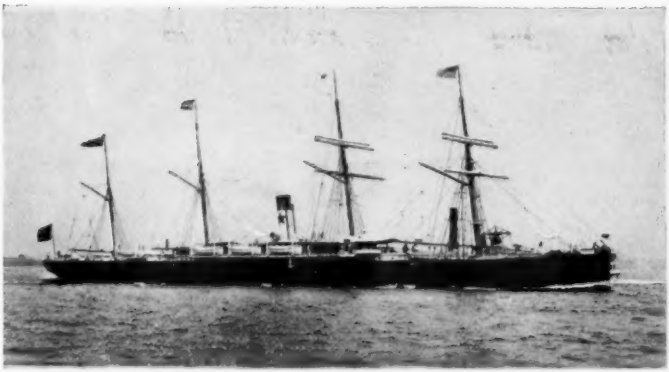
First Atlantic Steamer with Cabins Amidships. Length 420 feet; tonnage 3808.

was designed with the first-class passenger accommodation amidships, this being nearest the center of gravity, thus reducing many of the discomforts which had hitherto marked a voyage across the ocean. The Oceanic, therefore, was the pioneer of the present high-class ocean steamers in the matter of interior arrangements. She is still in existence, having been in use on the Pacific since 1875, other steamers taking her place on the Atlantic route. The following is taken from the Liverpool *Mercury* of May 4, 1895:

A NOTABLE STEAMSHIP.—The White Star steamer Oceanic arrived at Plymouth on Wednesday morning from Hong Kong and Singapore. The Oceanic was the pioneer steamer of the White Star fleet. She was launched on the 27th August, 1870, and has, therefore, been afloat a quarter of a century. It is given to few ocean steam-



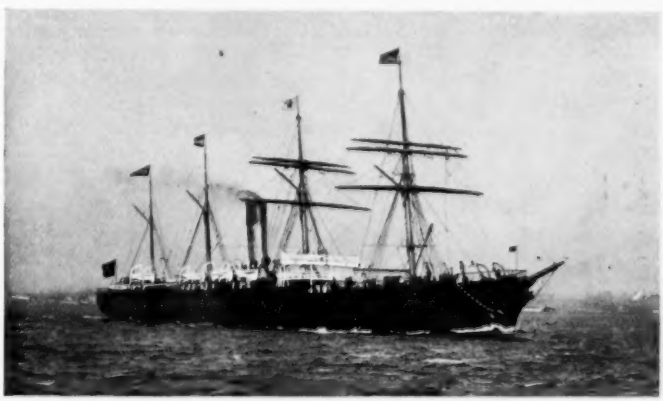
WHITE STAR LINE STEAMSHIP, BRITANNIC, 1874. ONE OF THE FINEST STEAMERS EVER BUILT. LENGTH 455 FEET; TONNAGE 5004.



RED STAR STEAMSHIP, BELGENLAND. 1878.

Length 402 feet; tonnage 3692.

ers to do such marvellous work as the Oceanic has done. Coming as an entirely new departure, the veritable type of the modern passenger liner, with saloon and state-rooms amidships and other innovations, she ran thirty three voyages with great success, and achieved a high reputation for speed and comfort in the Liverpool and New York trade. She was then sent out in April, 1875, just 20 years ago, to the Pacific, to run between San Francisco and Hong Kong under charter to the Occidental and Oriental S. S. Co. of San Francisco. At the end of 1879 she came home to be reboilered, re-



RED STAR [AMERICAN] LINE, STEAMSHIP WAESLAND. ORIGINALLY CUNARD STEAMSHIP, RUSSIA, 1867.

Length 358 feet; tonnage 2959.

INMAN LINE STEAMSHIP, CITY OF CHESTER, 1873.

Length 475 feet; tonnage 4770.

INMAN LINE STEAMSHIP, CITY OF BERLIN, 1875.

The largest and one of the fastest steamships of the time; tonnage 5526.

turning to her station in March, 1880, since when she has not once been taken off, but has continued uninterruptedly performing her work with regularity and efficiency.

Following the Oceanic came the Baltic, Republic, Adriatic, and Celtic, built and put into commission the following year. Besides these there were the Asiatic, Tropic, Gaelic, and Belgic, which were afterwards sold. Two of the most important vessels that have been built for the Atlantic trade were the Britannic and Germanic White Star liners, which appeared in 1874 and 1875, these steamships being the first to reduce the passage to less than 7½ days. While dozens of faster and larger steamers than these have since been built, these two splendid craft are as comfortable, and make their voyages with as much regularity, and almost as swiftly, as the more modern vessels.

The American Steamship Company was organized in Philadelphia in 1871 with a capital of $2,500,000, and soon afterward contracted with William Cramp & Sons for the construction of four steamships of the first class, of 3000 tons burden, to ply between Philadelphia and Liverpool, *via* Queenstown. These boats were named Pennsylvania, Ohio, Indiana, and Illinois, and have been running constantly since they were launched. They have a capacity of 100 first-class, 75 intermediate, and 800 steerage passengers, and 3500 to 4500 tons of freight. The State Steamship Line was established in 1872, running its ships between Glasgow and New York. The Red Star Line of steamers, between Antwerp and New York and Philadelphia, was inaugurated in 1873, and has been an important North Atlantic line since its inception. The Monarch Line was established in 1874, but went out of existence after about 10 years of service. The Warren Line of steamers, from Liverpool to Boston, and the Wilson Line, from Hull to New York, came into existence in 1875. The Leyland Line of steamships started in 1876, on the Liverpool and Boston route, and Johnson & Co. began running steamers between Liverpool and Baltimore in 1880.

The Cunard Line screw steamship Bothnia came out in 1874, and, as an example of the wonderful progress achieved since the first steamer of the line, the Britannia, built in 1840, crossed the ocean, the following facts are given. The Britannia measured 1139 tons and had a capacity for but 225 tons of cargo, while the Bothnia, of 4556 tons, could carry 3000 tons, or nearly fourteen times as much, though only four times larger. The Britannia carried 90 passengers, whereas the Bothnia had accommodations for 349. The former steamed 8½ knots, while the latter steams 13 knots an hour, or more than half as quick again, with less than half the coal per indicated horse power per hour, and at about the same fuel consumption per mile run.

It required 6 tons of coal to carry a ton of freight across the Atlantic on the paddle steamship Persia, built in 1855, whereas but $\frac{1}{3}$ ton of coal per ton of freight was used on the Arizona in 1880, although the latter vessel was twice the size of the old Cunarder.

As a comprehensive summary of the principal points of interest in this article the table below is presented. It will be interesting to note the tendency in the later designs as shown by the dimensions given in the fourth column.

PROMINENT TRANSATLANTIC STEAMSHIPS, 1856–1880.

Year Built.	Name.	Tonnage	Le'th; br'th; depth, in feet	Remarks.
1854–9	Great Eastern	22500	680×83×58	Largest vessel ever constructed. Built on Thames.
1856	Borussia	2349	317×40×28	First Hamburg-American steamer; built by Caird & Co., Greenock.
1858	Bremen	2674	318×40×26	First North German Lloyd steamer; built by Caird & Co., Greenock.
1860	Marathon	2403	336×36×25	Cunard Line; built by Thompson, Govan; lengthened 1873.
1862	Scotia	3871	379×47×30	Cunard Line; last paddle steamer; built by Napier & Sons.
1862	China	2529	326×40×27	Cunard Line; built by Napier & Sons, Glasgow.
1866	City of Paris	2875	385×40×26	Inman Line; built by Tod & McGregor, afterwards Tonquin.
1866	Manhattan	2869	335×42×28	First Guion Liner; built by Palmer, Jarrow-on-Tyne.
1867	Russia	2959	358×42×28	Cunard Line; afterwards Waesland.
1867	France	3572	385×42×28	National Line; built in Liverpool.
1869	City of Brussels	3747	390×40×27	Inman Line; built by Tod & McGregor, Glasgow.
1870	Italy	4169	389×42×28	National Line; first with compound engine; built by Elder.
1870	Wisconsin	3700	378×43×32	Guion Line; built by Palmer; mate to Wyoming.
1871	Spain	4512	425×43×36	National Line; built by Laird Bros.
1871	Oceanic	3208	420×41×32	First steamer White Star Line; built by Harland & Wolff.
1871	Adriatic	3888	437×40×31	White Star Line; built by Harland & Wolff, Belfast.
1872	Montana		400×43×40	Guion Line; had mate in Dakota.
1872	Pennsylvania	3128	343×43×24	American Line; Ohio, Indiana, and Illinois; sister ships.
1872	California	3410	361×40×31	Anchor Line; built at Govan, Scotland.
1873	Ethiopia	4005	402×40×33	Anchor Line; built at Govan, Scotland.
1873	City of Richmond	4780	440×43×34	Inman Line; built by Tod & McGregor, Glasgow.
1873	City of Chester	4770	475×44×36	Inman Line; built at Greenock.
1874	Bothnia	4535	422×42×34	Cunard Line; built by Thomson, Glasgow.
1874	Anchoria	4168	408×40×33	Anchor Line; built at Barrow, Eng.
1874	Scythia	4556	425×42×35	Cunard Line.
1874	Gellert	3584	375×40×32	Hamburg-American Line; built at Glasgow.
1874	Britannic	5004	455×45×33	White Star Line; built by Harland & Wolff.
1875	City of Berlin	5526	488×44×34	Inman Line; built by Caird, Greenock.
1875	Germanic	5008	455×45×33	White Star Line; built by Harland & Wolff.
1877	Devonia	4269	400×42×32	Anchor Line; built in Barrow.
1878	Gallia	4809	430×44×34	Cunard Line; built by J. & G. Thomson.
1878	Belgenland	3692	402×40×30	Red Star Line; built by Barrow S. B. Co.
1879	Buenos Ayrean	4005	385×42×30	Allan Line; first steel transatlantic steamer.
1879	Arizona	5164	464×46×37	Guion Line; built by Elder & Co, Glasgow.
1880	State of Nebraska	4000	385×43×34	State Line; built by Lpl. Forge Co., Glasgow.
1880	Furnessia	5494	445×44×34	Anchor Line; built by Barrow S. B. Co.

The steamers of the Inman Line have always held their own in the race for leadership on the North Atlantic. Their steamers City of Paris, 1864, City of Brussels, 1869, City of Chester, 1873, City of Richmond, 1873, and City of Berlin, 1874, were among the largest and finest when they appeared. The latter was the largest of the fleet running across the Atlantic, and made a splendid record as soon as she appeared, eclipsing the time made by the White Star Line steamers.

One of the most noteworthy steamers of the time was the Guion Line steamer Arizona, which came out in 1879. She was of large size and superior finish, having many improvements and machinery of a new design, the compound engine having three crank shafts with three cylinders. She made the fastest transatlantic passages in 1879 and 1880.

At the close of the year 1880 the first steel steamship for the Liverpool & New York trade, the Cunard liner Servia, was being built. While this vessel was the first one constructed of steel to ply to New York, yet the honor of the first transatlantic steel steamship belongs to the Allan Line,—the Buenos Ayrean, 1879, and Parisian, 1880, being the pioneer steel boats. Soon after 1880 the first twin screw and the first triple expansion engined steamers appeared.

FASTEST PASSAGES OF TRANSATLANTIC STEAMERS BETWEEN NEW YORK AND QUEENSTOWN, 1856–1880.

E, eastward; W, westward.

1856	Persia, Cunard Line,	E,	2732	knots	.....	9	days	1	hour	45	min.
1857	" " "	W,	3070	"	.....	9	"	21	"	41	"
1863	Scotia, " "	E,	2731	"	.....	8	"	3	"	0	"
1864	" " "	W,	2783	"	.....	8	"	15	"	45	"
1866	" " "	W,	2851	"	.....	8	"	4	"	34	"
1867	City of Paris, Inman Line,	W,	2700	"	.....	8	"	4	"	1	"
1869	City of Brussels, " "	E,	2786	"	.....	7	"	22	"	3	"
1872	Adriatic, White Star "	W,	2778	"	.....	7	"	23	"	17	"
1873	Baltic, " " "	E,	2843	"	.....	7	"	20	"	9	"
1875	City of Berlin, Inman, "	W,	2829	"	.....	7	"	18	"	2	"
1875	" " " "	E,	2820	"	.....	7	"	15	"	28	"
1876	Germanic, White Star "	E,	2894	"	.....	7	"	15	"	17	"
1876	Britannic, " " "	W,	2795	"	.....	7	"	13	"	11	"
1876	" " " "	E,	2882	"	.....	7	"	12	"	41	"
1877	Germanic, " " "	W,	2830	"	.....	7	"	11	"	37	"
1877	Britannic, " " "	W,	2802	"	.....	7	"	10	"	53	"
1879	Arizona, Guion Line,	E,	2810	"	.....	7	"	8	"	11	"
1880	" " "	W,	2761	"	.....	7	"	10	"	47	"

GENERAL PARTICULARS OF THE GREAT EASTERN.

Length of upper deck.....692 ft.
Length between perpendiculars...680 "
Breadth across paddle-boxes....118 "
Breadth of hull.....83 66
Depth, from deck to keel.....58 "
Number of decks.....4
Displacement.....32,160 tons
Number of masts.....6
Diameter of masts { 2 ft. 9. in. to 3 ft. 9 in.
Canvas, full sail.....6500 sq. yds.
Number of anchors.....10
Number of boats.....20
Tonnage (old measure).....22,500 tons
Storage for cargo.....6000 "
Capacity of coal bunkers....12,000 "
Draft of water, light.....15 ft. 6 in.
Draft of water, loaded.....30 ft.
Water-tight compartments.....12

Paddle Wheels.

Diameter of paddle wheels.....56 ft.
Weight of paddle wheels.....185 tons
Length of buckets.....13 ft.
Width of buckets.....3 "
Number buckets each wheel.....30
Length of shaft.....38 ft.
Weight of shaft.....30 tons
Length intermed. crank shaft...21½ ft.
Weight intermed. crank shaft....31 tons

Paddle Engines.

Nominal horse power.....1000
Number of cylinders.....4
Diameter of cylinders.....6 ft. 2 in.
Weight of cylinders, including piston and rod.....38 tons
Length of stroke.....14 ft.
Strokes per minute.....14

Paddle Engine Boilers.

Number of boilers.....4
Furnaces to each.....10
Length of boilers.....17 ft. 6 in.
Width of boilers.....17 " 9 "
Height of boilers.....13 " 9 "
Weight of each.....50 tons
Weight of water.....40 "
Area of heating surface.....4800 sq. ft.
Number of tubes.....400
Thickness of plates.....3-8 and 7-16 in.

Screw Propeller.

Diameter of screw.....24 ft.
Pitch of screw.....37 "
Number of blades.....4
Weight of screw.....36 tons
Length of propeller shaft.....160 ft.

Screw Engines.

Nominal horse power.....1600
Number of cylinders.....4
Diameter of each cylinder.....84 in.
Length of stroke.....4 ft.
Number revolutions per minute.....50

Screw Boilers.

Number of boilers.....6
Funnels to each boiler.....12
Length of boiler.....18½ ft.
Width of boiler.....17½ "
Height of boiler.....14 "
Weight of boiler.....57 tons
Weight of water.....45 "
Area heating surface.....5000 sq. ft.
Number of tubes.....420
Thickness of plater....7-16 and 1-2 in.
Number of auxiliary engines.....4
Number of donkey engines.....10
Total horse power, about.....12,000

Passenger Accommodation.

Number of passengers (1st class)....800
Number of passengers (2d class)...2000
Number of passengers (3d class)..1200
Aggregate length of saloons and berths.....350 ft.
Number of saloons.....10
Length of principal saloon.....100 ft.
Width.....36 "
Height.....13 "

WILL A BRIDGE ACROSS THE HUDSON RIVER PAY?

By Gustav Lindenthal.

INFORMATION on this point has been repeatedly asked, and an answer at this time appears appropriate. That a bridge over the Hudson river at New York is a pressing necessity is widely, and to many people painfully, known. The bridge for eight tracks (including approaches 3 miles long) authorized by congress from Hoboken in New Jersey to Twenty-third street in New York (admittedly the best location, and the only one worthy of serious consideration) will cost $21,000,000; $15,000,000 additional are required for right of way, approaches, and interest during construction. It will have a single span of 3100 ft. over the entire river. No saving in cost can be effected by a pier in the river, because a rock foundation can be had only at a depth exceeding 250 ft., involving hazardous and costly work. This was shown by the author years ago, and other engineers have since confirmed his judgment.

The steam and electrical railroads in New Jersey can be connected with those of New York city at a cost of $36,000,000, and, if this sum is paid out as fast as the work can be built, then 4 years will suffice for construction.

The bridge can be built only by private capital. It cannot, under the constitutions of the two States, be built at public expense, as was the existing Brooklyn Bridge, or as will be the new East River Bridge, which are both within the State of New York. Nobody assumes that congress would vote a credit for the bridge as an interstate route. Such a step would be regarded as a dangerous precedent.

Since money cannot be had for the bridge, either from the cities or States immediately interested, or from the national government, private capital alone must be looked to. That the railroad companies in New Jersey cannot very well aid in furnishing the capital was shown by the author in an article published in this magazine in November, 1893. The cost of the bridge is too great to be assumed by any one railroad, and a combination of several or all railroads for the purpose is impracticable: first, because of their rivalry in business; second, because of the great difference in their financial conditions. All, however, are willing to use the bridge on equal terms, if a separate company will build it in a location, equally acces-

sible to all. The local traffic, on electric cars, will be an indispensable source of revenue, and this is not controlled by the railroads.

The financing of the bridge must, therefore, be based, as was that of the elevated railroads, on the merits of the undertaking. The promoters must be able to show a traffic which, at low rates, will pay good interest on the investment and a profit commensurate with the risk of construction.

The location of the bridge with relation to the local traffic is of the first importance. The more local traffic it can command, and the nearer the bridge can be located to the ferry lines having now the heaviest passenger traffic, the greater the business it will get.

A more favorable location than that from Hoboken in New Jersey to Twenty-third street in New York could not well be chosen along the entire river front. It will be equally convenient to all the thirteen railroads and several electric traction companies in New Jersey and to the down-town business and up-town residential districts in New York. It will be in the very heart of the hotel and theatre region and of the retail business and shopping centre, which will furnish the largest amount of travel during the day, between the morning and evening rushes.

The situation is analogous to that which prevailed in New York before the elevated railroads were built (1875–6). Every one then wanted rapid transit to the upper part of the city, just as every one is now shouting for a bridge over the North river. When the proposition to solve rapid transit by building elevated railroads to Harlem was laid before New York financiers, there was apparently not one argument in its favor which would stand scrutiny. "Do you think," it was asked, "that people are going to walk several blocks and climb stairs to stations, and pay 10 cents [the only fare thought of then], when they can ride on the street cars for 5 cents, and get on and off where they please? Do you mean to tell us that an iron viaduct road, costing at least fifteen times as much for construction per mile as a horse-car line, will pay under such circumstances?"

All these arguments, moreover, were strongly endorsed by the horse car companies, which were, of course, hostile to the idea of dividing their traffic with the elevated railroads.

The risk was considered great, and the money had to be raised at extraordinary cost, and, had the promoters believed that the fares would in a few years come down to a uniform 5-cent rate, or had they believed that the elevated railroads would be compelled to pay damages to property owners along their lines, it is doubtful whether one dollar would have been subscribed toward their construction. But every one knows now that the undertaking was eminently successful.

The elevated railroads furnish a better basis for estimation of the probable revenue from local traffic over the North River Bridge than does the Brooklyn Bridge, because the latter was built at public expense, almost regardless of time and cost, and because its managers, when it was finally completed, had to defer to public sentiment, which was against such management of the bridge as would yield interest charges and running expenses. The Brooklyn Bridge—with terminals, only 1 mile long—is managed as a separate concern, without much regard to the connections at each end. It has its own terminals, cars, motors, and crews,—a fact which makes its operation very expensive. The enormous number of passengers are obliged to change cars at each end, climb stairs, and walk long distances before they can continue their journey.* It is safe to say that, if the Brooklyn Bridge were owned by a private corporation, its owners would be compelled by self-interest to so arrange the bridge that the elevated and electric roads of Brooklyn could run their cars directly over to New York. In the case of the North River Bridge this privilege will be enjoyed by all kinds of railroads in New Jersey.

The North River Bridge and the elevated railroads in New York have, therefore, the following features in common: dependence upon private capital for construction; opening up new territory for homes and residential purposes; saving of time and greater convenience in travel; and an undoubted prospect of a vast increase of traffic. The only difference is this,—that the necessity for the bridge is felt to be much greater than the necessity for the elevated railroads or for the Brooklyn Bridge was felt to be at the time of their construction.

The elevated railroads began with 10-cent fares, competing with the 5-cent fares of the street railroads. Applying that experience to the proposed North River Bridge, we may expect that at the start an average 5-cent fare in local traffic will very well compete with a 3-cent ferry fare or even a smaller one. The ferry carries the passenger merely from shore to shore, leaving him to walk from and to the cars, where he pays additional fares. For instance, a passenger from Jersey City Heights to the retail district near Madison square in New York has to pay at present 13 cents (for one ferry and two street-car fares), and do considerable walking besides. If he is lucky in not missing connections at the ferry, he may complete his trip in 40 minutes; otherwise, in 50 minutes. Over the bridge the same trip will take 8 minutes and cost

* In spite of these drawbacks, the traffic over the Brooklyn Bridge has increased from 8,823,000 in 1884 to over 43,000,000 in 1894, not counting the pedestrians (who pay no toll). Indirectly, it pays the two cities handsomely on the investment, and shows its great necessity side by side with the ferries, whose business, instead of having decreased, has, against all expectation, increased. The total number (bridge and ferry) of passengers across the East river now exceeds 135,000,000 per annum, against 41,000,000 ferry passengers in 1882,—1 year before the bridge was opened for traffic.

5 cents. Will not that saving of time and money increase travel immensely? Let experience elsewhere answer the question. With those who know the situation the conviction is strong that the bridge will cause the different cities and towns in adjacent New Jersey to grow into one dense metropolitan district, in population surpassing New York, where there is no more room for growth except to the far and inaccessible north.

Passengers from Bayonne and Greenville far away to the south will probably continue to use the ferries to lower New York in fine weather, but to the central part of New York they will use the bridge at all seasons as the shortest, cheapest, and most convenient route.

Passengers living in the pleasant suburbs of the Orange hills arrive now in one of the railroad stations in Jersey City or Hoboken, and walk to the ferry, on an average, 800 ft. After landing at one of the down-town ferry slips, the passenger finds no convenient cars to carry him to his office; he is obliged to walk (unless he chooses to hire the expensive cab) through the most disagreeable neighborhood of New York, with streets and sidewalks crowded and obstructed by every conceivable nuisance. He will gladly take, for a few cents more, the bridge route, from which the elevated railroad will carry him just where he wants to go, up or down town, with a saving in time of from 10 to 40 minutes. It will enable him and his family to come in the evening to New York to visit the concert or theatre, and return home, with no more trouble than if he lived near Central Park. People of a saving disposition may continue to use the ferries and climb over truck ladders. All American experience in passenger transportation, however, is against it. Increased convenience and saving of time always attracts traffic, in spite of somewhat higher fares; otherwise the elevated railroads in New York would have starved to death the first year.

As traffic increases, facilities can be extended, and passengers may have the further comfort of riding through from the Oranges to the Battery without change, on steam or electric cars, as the case may be.

As regards railroad passengers from a distance and with baggage, a higher rate of compensation over the bridge will be justified, and an average of 10 cents will be admitted as a moderate estimate. (Whether the toll be arranged in this or some other form is immaterial at present in discussing or estimating revenue.)

The number of ferry passengers crossing the North river in 1886 was 58,894,000; in 1890, 72,260,000; in 1894, nearly 85,000,000; and, at the present rate of growth, it will reach, in 1900, at least 100,000,000; 50,000,000 from Hoboken, Jersey City, and Newark; 38,000,000 from other towns; and 12,000,000 from a distance of 30

miles and over. On the New Jersey side, within a radius of 30 miles, there is a population of 1,250,000 tributary to the North River Bridge,—nearly equal to that on Long Island within the same radius, which at present supplies 135,000,000 passengers across the East river.

In the estimates of revenue, it is assumed that 40 per cent. of all passengers across the North river will use the bridge the first year,—namely, 32,000,000 local and suburban passengers at an average of 5 cents, and about 8,000,000 longer distance passengers with baggage, at an average of 10 cents; on the whole, 40,000,000 passengers at an average of 6 cents.

When it is considered that a large increase of population (larger than the ordinary rate of increase) will take place in the near-by towns and cities of New Jersey, in anticipation of the completion of the bridge, as soon as the work can be energetically prosecuted; that land for homes is cheap and unlimited in New Jersey within the sight of New York; that house rentals are only about one-half; and that a large region will be more quickly accessible than Harlem,—it cannot be said that either the number of passengers or the toll is placed too high. Still less will it be doubted that the number of passengers will rapidly increase from year to year. It is almost certain that the experience with the New York elevated railroads will be here repeated, if not outdone.

The growth of the elevated railroads was as follows: in 1879, 46,045,000 passengers; 1880, 60,832,000; 1881, 75,586,000; 1882, 86,361,000; 1883, 92,125,000; 1884, 96,703,000; 1885, 103,355,000; 1886, 115,107,000; 1887, 158,963,000; 1888, 171,529,000; 1889, 179,497,000; 1890, 185,833,000; 1891, 196,714,000; 1892, 213,692,000; 1893, 221,407,000.*

This increase took place without any increase in the length (32 miles) of the four parallel roads constituting the elevated railroad system in New York, and in competition with parallel street-car lines, whose business is equally large and growing. With such an experience before us, the conclusion can hardly be escaped that the bridge traffic, under the much more favorable conditions above-named, will certainly grow at a similar rate, and in 10 years reach, if not overlap, 160,000,000 passengers.

The North River Bridge is intended to be a thoroughfare for the

* The entire street railroad traffic of New York city in 1887 was 164,000,000 passengers, or 148 trips per capita of population (1,107,000). Last year (1894) the streets and elevated railroads carried a total of 460,000,000 passengers, or at the rate of 250 trips per capita of population (1,840,000), proving that increased convenience of travel increases the capita rate of travel.

railroads, and not an independently-conducted transportation route, like the Brooklyn Bridge. The Brooklyn Bridge carries one-third and the ferries two-thirds of the total number (135,000,000) crossing the East river, because the latter is comparatively narrow, the ferry lines numerous and conveniently located, and the time of the trip short. The passengers across the Brooklyn Bridge are not spared the discomfort of changing cars, and the consequent loss of time.

The North river, on the other hand, is twice as wide as the East river, and the ferry lines are less conveniently located, particularly to the business center of New York. The saving of time will be comparatively very much greater, with the almost certain result that within a few years the bridge passengers over the North river will greatly outnumber the ferry passengers.

In the case of the North River Bridge there will be an important saving in the cost of terminals. The suburban traffic in New Jersey is being gradually absorbed by the electric railroads, which will not require the extensive terminal arrangements in New York that are needed for locomotive trains. A loop connection between the incoming and outgoing tracks will be sufficient. A very large passenger traffic can be handled with that arrangement. The through trains of all kinds require more room, but for these the railroads, it is believed, will prefer to provide their own passenger stations.

Another item of revenue will be that of perishable freight (including milk, fruit, meat, and other food products), of which there are about one thousand one hundred cars daily. The saving of time for this freight is so important that all of it can be expected for the bridge at the low tolls contemplated. In addition there is the express; then the through freight to and from New England (which will be limited only by the capacity of the New York Central Railroad to take care of it), and a certain proportion of the high-class local freight, which will depend upon the facilities for loading and unloading. The arrangement of freight stations separately built and owned by the railroads in St. Louis in connection with the Merchant Bridge gives an indication of the methods likely to be evolved for New York.

The rental from telegraph and telephone wires is also a considerable item, amounting, for instance, over the Brooklyn Bridge to over $22,000 per annum, and sure to be twice as much over the North River Bridge.

There is no doubt that the revenue will greatly increase from year to year, and in 10 years probably will reach the same amount as on the elevated railroads ($11,000,000), which have no revenue worth mentioning except the passenger traffic at 5-cent fares, and yet pay good interest on a capitalization of $70,000,000. It is true that more money

will be invested, after the completion of the bridge, for the enlargement of terminals. But these will earn their own rentals.

The revenue for the first year, conservatively estimated, is as follows:

1.	Toll from 40,000,000 passengers at 6 cents average,	$2,400,000
2.	Toll from express, perishable and high-class freights, and from other low-class and through freight to and from New England. (The annual number of loaded freight cars now crossing the river on floats is over 1,500,000, and the number of express cars with New York freight, but not crossing the river, is about 110,000.) 400,000 loaded express and freight cars at an average of $4.00,	1,600,000
3.	Telegraph and telephone wire rentals,	30,000
4.	Rentals from real estate (below the tracks) acquired and necessary for right of way and improved for renting purposes, 3 per cent. net on 3,000,000,	90,000
	Total,	$4,120,000
	Deduct from the above for maintenance, taxes, and other expenses (railroads preferably using their own equipment and crews, and paying their own operating expenses),	820,000
	Balance,	$3,300,000

sufficient to pay 6 per cent. on $55,000,000.

Modern ware and storage houses, similar to those of London, equipped with elevators for moving cars directly from the tracks to the warehouse floors, will reduce to a minimum the cost of handling, distribution, and transfer of freight,—a business indispensably connected with the bridge, joined as it will be to the railroad system of the entire continent. The saving of time and cost in the transfer of about 6,000,000 tons of merchandise will be an item so important to the commerce of the city that a small proportion of that saving for greatly improved service rendered will add vastly to the resources of the Bridge Company.

The North River Bridge is purposely so designed that its capacity may be increased from eight to fourteen tracks, a precaution the necessity of which was taught by the experience with the elevated railroads and the Brooklyn Bridge, which long ago became too small. The addition of six tracks on a second deck, when it becomes necessary, will cost only about $3,500,000, against $40,000,000 for a new six-track bridge with new approaches and right of way.

The brutal crowding in the cars of the elevated railroads and Brooklyn Bridge should not be taken as a standard for transportation capacity. But, assuming ten thousand passengers per track per hour, one-quarter of the passengers may still have to stand up. On special and rare occasions, when extraordinarily large crowds have to be transported, the capacity per track and per hour may reach fifteen thousand passengers.

Of the eight tracks over the bridge two are intended for freight, two for express trains, and four for suburban and local trains with steam or electric power. During commission hours the freight tracks may be utilized also for suburban trains. The capacity of three tracks in, and as many out, would then be available for passenger transportation with a maximum per hour of forty-five thousand passengers. Assuming the number of commission hours to be 5 out of 24, and the traffic of the remaining 19 hours to be equal to that of the 5 commission hours (approximately true for the elevated railroads), then six tracks will suffice to transport from 450,000 to 500,000 passengers per day, or from 165,000,000 to 180,000,000 passengers per year,—a number which will be reached much sooner than it was on the elevated railroads.

Not only, then, may the question whether the North River Bridge will pay be answered emphatically in the affirmative, but the wonder will be that it was ever asked. It is evident, however, that the bridge must be located, first, with reference to local passenger traffic, purely railroad traffic being a secondary matter. Fortunately the location at Hoboken meets both demands equally well.

The existing facilities are ample for the prompt execution of this large work in 4 years with the money ready to pay for it as promptly as the work can be put up,—all of it, for half a bridge is worse than no bridge. It is nothing to the point that the Brooklyn Bridge required three times, and the Forth Bridge in Scotland twice, 4 years. Since their time, very great progress has been made in rapid construction on a large scale, and a great deal depends on a thorough preparation and organization of the work before it is commenced. It can readily be contracted for directly with the largest manufacturers and builders, under proper guarantees, at bottom prices for cash. The project has the further advantage that the legal powers and rights of the company have already been adjudicated in the supreme court of the United States, so that the work may not hereafter be interrupted for long periods by injunctions and law suits. It is well known that delays from that cause have been disastrous to several large undertakings in this country.

THE LIMITS OF ELECTRIC POWER TRANSMISSION.

By Alton D. Adams.

IN every branch of engineering there is a wide difference between the physically possible and the commercially practical, and the electric industry has suffered repeatedly from a failure to recognize this fact. During the past year much has been written which might leave the impression that the electric transmission of power over very considerable distances, up to several hundred miles, is a commercially practical undertaking; and that power from Niagara Falls or the coal fields of Pennsylvania can be delivered at the large cities of our eastern States at a good profit to the promoter.

The electric transmission of power over various distances up to about 100 miles has been carried out in several cases, but data showing the cost per h. p. year of power delivered over such distances are very scarce. While these long-distance transmissions may form attractive experiments, it must be demonstrated that it is possible to thus deliver power more cheaply than it can be generated at the point of use, before they can become common. The cost of transmitted power increases with the distance, and it is obvious that, assuming absolutely free power at the start, a distance may be chosen great enough to consume its entire value in cost of transmission. To make, then, the transmissions of power commercially practical, it is necessary that the cost of transmission be less than the difference between the value of the power at the starting-point and its value at the point of delivery.

As steam power is the one generally available in cities, its cost may be fairly taken as that which the total cost of transmitted power must not exceed. In the selection of a figure for the cost of steam power in cities, it is fair to assume high-class working conditions, as an enterprise for the sale of power on a large scale would naturally procure the best equipment. When power is to be transmitted electrically, there must be, at the point of delivery, electric motors of the desired capacity, and, at the point where power is available, electric generators of enough greater capacity to make up for losses in line and motors. When very high voltages are employed, it is also necessary to use transformers at the generating and receiving stations, having an aggregate capacity equal to that of motors and generators. A uniform price of $20 per h. p. capacity is a low one to assume for generators, motors, and transformers. A line to connect the apparatus at the generating and re-

ceiving stations must also be provided, whose cost will be determined by the special conditions of each case.

An average commercial efficiency of 90 per cent. for generators and motors, and of 95 per cent. for transformers, is a fair assumption ; the line loss will be determined by the conditions of each case. With these efficiencies and no line loss whatever there can be delivered by motors $.90 \times .90$, or 81 per cent. of the power supplied to the generators, when no transformers are used ; or, with transformers, the motors will deliver $.90 \times .95 \times .95 \times .90$, or 73 per cent. of the power supplied to the generators, with no allowance for line loss, which will of course lessen the efficiencies. A case in which it is necessary to deliver 1000 h. p. a distance of 25 miles may be taken as an illustration. It is desirable to use a pressure of 10,000 volts in this case, for economy of line conductor and transformers would commonly be employed to attain this voltage. Allowing a loss of 10 per cent. in line, there must be supplied to the generator $\frac{1000}{.90 \times .95 \times .90 \times .95 \times .90}$ or 1520 h. p., and the generator will deliver $1520 \times .9$, or 1397 h. p. The combined capacities of motor and generator are, therefore, $1000 + 1397$, or 2397 h. p.; adding an equal amount for transformers, we have a total required capacity of 4794 h. p , which, at $20 per h. p., has a value of $95,880. To transmit 1000 h. p. at 10,000 volts 100 miles, at a 10 per cent. loss, requires about 168,700 lbs. of bare copper wire, which, at 12 cents per lb., has a value of $20,000. The cost of a fair pole line, and the erection of the wire thereon across a country where no special impediments to the work exist, would be approximately $400 per mile, making $10,000 for 25 miles.

Summing up these amounts, we have :

Cost of electrical machinery per delivered h. p.	$95.88
" " wire " " "	20.00
" " pole line " " "	10.00
Electrical instruments and accessories per h. p.	1.00
Total cost of electrical equipment per h. p.	$126.88

Allowing 5 per cent. for depreciation and repairs, 3 per cent. for operating expenses, including care of line, and 10 per cent. for interest and dividends, we have a total of 18 per cent. of the original cost ($126.88),—that is, $22.83 per h. p. year for transmission expenses.

With well-equipped steam plant, and coal at from $2.00 to $3.00 per ton, the cost of steam power may be fairly taken at $25 per h. p. year of 312 10-hour days and $45 per h. p. year of 365 20-hour days. The transmission-cost of $22.83 per h. p. year very nearly equals this cost of steam power ; so that, under ordinary conditions, for 312 10-

hour days' work, power must be delivered to the electric generators absolutely free to warrant its transmission a distance of 25 miles under assumed conditions.

If power is required for 365 20-hour days, about $20 per h. p. year may be allowed for the cost of power delivered by motor. As shown above, there must be furnished to the generator 1520 h. p. when 1000 h. p. is delivered by motor,—that is, 1.52 h. p. furnished for each h. p. delivered.

Applying this fact to the last case, it appears that for nearly continuous work, which represents the most advantageous condition for the transmission of cheap power, the maximum price of power at generator for a 25-mile transmission must not reach $\frac{\$20.00}{1.52}$, or $13.33 per h. p. year, as the operating expenses of electrical plant are increased by a 20-hour day.

It is certain that, with absolutely free fuel, steam power cannot be generated at less than about $25 per h. p. year of 365 20-hour days; so transmitted steam power, from points where fuel is cheap or even free, is out of the question in the above case.

The cost of water power varies greatly, but it can be procured at some points at less than $13.33 per h. p. year, and this would seem to make the 365 20 hour day transmission commercially practical.

Were it thought practical to employ generators and motors of the necessary voltage, thus avoiding the cost of and losses in transformers, the cost of transmission given above could be considerably reduced, and it is probable that many water-power transmissions from 5 to 20 miles can be profitably carried on with such apparatus.

The above is sufficient to show that the electric transmission of power on a commercial basis is limited to much shorter distances than is generally supposed.

If alternating-current generators and motors, to work at 10,000 volts or over, can be obtained, or if a number of continuous current generators and motors are connected in series to attain the desired voltage, the cost of and losses in transformers may be avoided, and the limits over which transmission is practical considerably extended. It is probable that there are many cases where the transmission of moderate amounts of power from 25 to 50 miles is commercially practical with the last-named classes of apparatus.

There are, of course, special cases, as those of mines among the mountains, where the cost of steam power is excessive, which will warrant a much larger transmission cost per h. p. than that indicated above.

It is sometimes practical to deliver transmitted electric power directly

to individual consumers at the receiving station, and thus save the cost of additional generators and motors; this operates to extend the distance over which transmission can be carried on at a profit.

When the transmission of power derived from waterfalls is under consideration, it should be borne in mind that either calculations must be based on the minimum power in the dryest seasons, or else steam power must be supplied to make up the deficiency. This last consideration alone often suffices to render impractical what at first seems a promising opportunity for power transmission.

When the transmission of power from a distance and its distribution for general purposes are under consideration, it should be borne in mind that reliability is the first great requirement of the majority of users. In the early days of electric lighting one of the hardest arguments for the central-station manager to answer was that the lamps would and did occasionally go out, in consequence of various accidents to the machinery or line. It is interesting to consider the state of affairs that would exist were a considerable part of New York city deprived of light and power during several hours or a day, while gangs of linemen hurried to some point in the central or western part of the State to repair the supply line, broken perhaps by a heavy storm or washout.

Some of the conditions which combine to render electric service from central stations in large cities reliable are duplicate machinery, underground wiring, frequent inspection, and the accessibility of circuits. These conditions are hard to attain in the electric transmission of power for long distances across country, as the interest on duplicate machines would be a considerable sum, underground wiring would be out of the question because of the expense, and overhead lines across country would be damaged by severe storms.

On the score of reliability alone, it seems doubtful whether any plan for the general use of energy transmitted from a great distance would be permanently successful, for a substantial coal-pile in the cellar would be far more assuring to the average householder, especially in the winter, than a slender wire exposed for 100 miles or more.

It is very evident, however, that all plans for the transmission of power from great waterfalls or of power derived from cheap fuel at the mines, with a view to competition with steam power produced in our large cities, are based on a misapprehension of the facts, and can only result in financial disaster, if attempted. The electrical transmission of power can certainly be accomplished over very great distances when expense is no object, but under usual circumstances it cannot compete commercially with that great vehicle of long-distance power transmission,—an ordinary coal car.

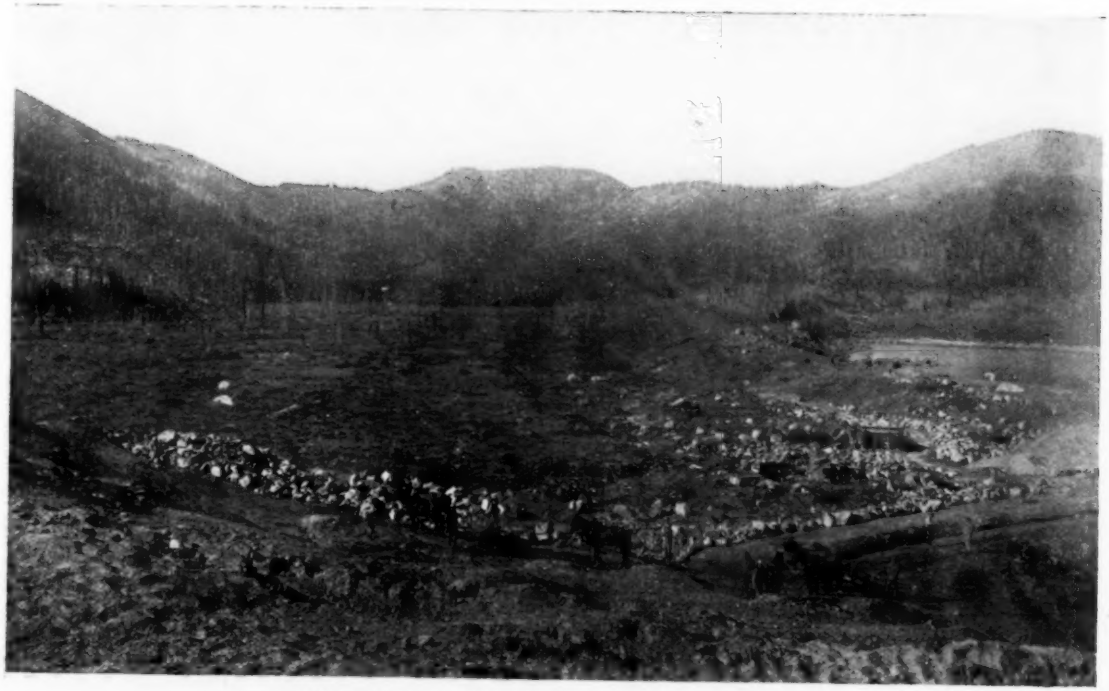
THE PIKE'S PEAK AND COLORADO SPRINGS WATER WORKS.

By Arthur Lakes.

THE localities from which many of the cities of the world derive their water supply are among the most beautiful and interesting spots on earth. This is particularly the case when such supplies have their source in mountain regions adjacent to or not very remote from the cities that lie along their borders. These mountain lakes and tarns, often nestling among the highest peaks, fed either directly from the snow or from streams whose source is the snow, provide the purest water imaginable. From a geological point of view these lakes and their surroundings are often full of graphic interest, for in many cases these natural reservoirs have been hewn out by ancient glaciers or have been dammed back by glacial moraines, piles of boulders left by the retreating and melting ice.

The water of mountain lakes is exceptionally clear and pure, because little exposed to contamination by decaying vegetable matter, and often not at all by animal impurities; and also because these lakes are deep natural settling places for silt and other matters in suspension. Thus the turbid Rhone enters the lake of Geneva full of mud, and leaves it pure, the suspended matter having been dropped in the lake. To increase storage capacity the water line may have to be raised by heightening its barrier at the outlet by an artificial dam. The extent to which the water level of a lake can be raised depends upon the area of the lake, the influx, and the supply withdrawn. Where there is no natural lake, an artificial one can be formed by a dam thrown across a narrow ravine. This reservoir must be formed on an impervious stratum, and be of more or less impervious material. Sometimes the nature of the ground and amount of storage require a series of storage reservoirs at different levels. Six such reservoirs supply Manchester (England) from Longderdale valley in steps, by dams from 70 to 100 ft. high.

The capacity of a reservoir depends on the contour levels of the valley, and the height of the dam retaining it. A small additional height often adds largely to the capacity. High dams are sometimes erected; that of the Entwistle embankment at Bolton (England) retains a reservoir 120 ft. deep. A dam at Villar Madrid (Spain) is 158 ft. from base to water level, and one at St. Etienne (France) 164 ft. A reservoir dam may be constructed as an earthwork embankment sloping



LAKE MORAINE RESERVOIR BASIN. BEGINNING CONSTRUCTION.

LAKE MORAINE RESERVOIR AND DAM.

1. Baldy Mountain. 2. Road to Seven Lakes. 3. Pipe from Upper Reservoir Discharging into Lake. 4. Reservoir. 5. Original Moraine and Lake before Reservoir was Enlarged. 6-7. Cog Railroad to Peak. 8. Pike's Peak and Crater. 9. Natural Discharge of Lake.

on each side, with a water-tight puddle of clay. The latter must be carried down to a solid, impervious bed. A masonry dam may be used, if a solid rock foundation is obtainable. Small dams are sometimes placed across the upper end of reservoirs to catch and deposit sediment before the stream reaches the main reservoir.

A mountain reservoir discharges by gravitation to the desired locality by canals, tunnels, aqueducts, or pipes. In olden times aqueducts were built; now hills are tunneled and valleys crossed by inverted syphons, and water is conveyed by metal pipes or flumes.

Pike's peak is 14,147 ft. above the sea and about 9000 ft. above the prairie. From its base at Manitou to the city of Colorado Springs is about 6 miles; from Manitou to the top of the peak by the cog railroad, 9 miles. It is a colossal mass of red granite. This is, in general, quite coarse, but towards the summit it is porphyritic and has a finer grain. From a mining point of view the mountain offers few attractions. The massive granite so often exposed in the steep cliffs shows but few veins of a metalliferous character. Owing to the coarse structure of the granite and the oxidation of its mica component, it is subject to rapid superficial decay, and whole mountain slopes are covered with a thick coating of coarse gravel, resulting from superficial atmospheric action.

The summit of the mountain is cloven on all sides by deep ravines, terminating in pits, often occupied by beautiful lakelets. These deep pits are popularly supposed to be "craters,"

LAKE MORAINE. RESERVOIR NO. 4, PIKE'S PEAK AND COLORADO SPRINGS WATER WORKS.

RESERVOIR NO. 2 BEFORE CONSTRUCTION.

but are in reality only the punch bowl excavations made by glaciers. Though the mountain is doubtless of semi-eruptive plutonic origin, having been extruded from the bowels of the earth at an early period in a semi-igneous state, there are no signs of modern lavas or craters, such as might be expected if at any time the peak had been the seat of a volcano. From these deep pits near the summit long and narrow valleys radiate downwards to the base. The profile of the mountain in some cases shows a descent by a series of steep steps from 500 to 1000 ft. deep, connected by narrow and somewhat level bottomed meadow valleys. Starting from a wide amphitheater about a thousand feet be-

RESERVOIR NO. 2, PIKE'S PEAK AND COLORADO SPRINGS WATER WORKS.

HEAD OF RUXTON CREEK PIPE LINE.

RUXTON CREEK PIPE LINE. ENGINEERS CAMP.

low the summit on the southwest side of the first step is a plunge from this over a steep precipice of granite 500 ft. high into a ravine following the course of Beaver creek. At its head is the highest reservoir at present used, known as No. 2; capacity, 97,000,000 gals. The hills or ridges on either side of this ravine are covered with enormous boulders left by the glacier. Other ravines come in, tributary to this, such as those of Boehmer and Sackett creeks, each with its local lake or natural reservoir near the head of its ravine. Following the valley of Beaver, it comes to an end in a *cul de sac* under Bald mountain,

RUXTON CREEK PIPE LINE, AT "HALFWAY HOUSE."

BOEHMER CREEK INTAKE.

where there are congregated upwards of seven beautiful bodies of water known as the "Seven Lakes," occupying basins among the moraines left by the glacier. From this point there is no open outlet to drain the lakes into Lake Moraine. To accomplish this a tunnel about 2500 ft. would have to be made through Mt. Baldy; but a short distance up Beaver creek is a comparatively low pass 100 ft. above the valley of Beaver, called the Seven Lakes divide. From this another great step descends 1000 ft. into the deep wide ravine occupied by Lake Moraine. Lake Moraine proper is a beautiful little

TUNNEL UNDER ELEPHANT ROCK, ½ MILE ABOVE MANITOU.

piece of water, covering about 20 acres, formed at the east end of the outlet of the ravine by a circular moraine left by the glacier. At one time the whole valley was occupied first by a glacier, and later by a lake over a mile in length, dammed back by a wide moraine thrown right across the valley; but at some time this principal moraine was broken through, and the water of the lake was discharged down a steep narrow ravine along the path of what is called Ruxton creek, leaving only the small circular lake behind it. Lake Moraine and its enlargement constitute the next and main reservoir. In the ravine below the lake there are ample evidences of the pathway of the glacier in cliffs of granite on either side rounded into *roches moutonnées*, or glacial "sheep backs." Thence the stream bounds unchecked down Ruxton cañon over huge boulders and in sparkling cascades to Manitou, where it joins Fountain creek and eventually finds its way to the Arkansas river. Though there are other ravines and creeks from Manitou, such as Bear creek and Cheyenne creek, which are made to contribute their waters to the Pike's peak supply for Colorado Springs, yet it is along the creeks mentioned and the course we have outlined that the main drainage system of the mountain and that used for reservoirs is located.

The peak itself would seem to be the "father of waters," although it retains in summer but little of the snow which covers its surface in the winter, and is snow capped but for a day by a passing storm. Yet, if we descend the west side a few hundred feet over a deep mass of angular boulders and listen, we hear, seemingly within the mountain, like the *vox humana* of a distant organ peal, the voice of many unseen waters, which find their way below the thick, loose *débris* into the wide Amphitheater on the southwest face of the peak.

This great Amphitheater was evidently the gathering ground of the great ice mass from which, when the basin overflowed, glaciers descended into the lower lands. It is now the principal watershed of the peak and of its drainage system. The bottom is dotted with lakelets, occupying basins formed of morainal *débris*. These basins sometimes communicate with one another by rills, and in the largest the principal branches of Beaver creek have their source, one branch flowing southwest in the direction of Cripple creek, and the other over the step we have described to Seven Lakes, receiving on its way various tributaries.

The marks of the great ice mass are very apparent on the Amphitheater. All red granite bosses are rounded into smooth "sheep backs," and the bottom is strewn with morainal boulders and circular basins of morainal *débris* occupied by the lakelets. Where the ice mass slid over the steep cliff into reservoir No. 2, the rocks are

planed down as by a giant plane. Doubtless at this point crevasses opened in the ice, as they are wont to do when the ice passes over a precipice.

There is nothing in the way of animal life to sully or contaminate the ethereal purity of the water of this mountain valley save the few wild denizens of the place—the marmot, the coney, the mountain ptarmigan, the eagle, and an occasional deer. This great Amphitheater is at present not much used as a reservoir, but in the near future there probably will be stored in it a large body of water by damming up the outlet of the fork of Beaver flowing southwest, as well as by opening communication between the various lakelets. The capacity will be more than 525,000,000 gallons. To get this water out of the Amphitheater will require some engineering skill. The work will be begun next fall by Mr. H. I. Reid, the city engineer of Colorado Springs. He has three plans in view. One is to run a tunnel from the Amphitheater, 5000 ft. long, down into reservoir No. 2; another is to carry the water by a flume 5 miles long by a roundabout course among the cliffs and hills; and a third, the one preferred as cheapest and most novel, is to pipe the water from the end of the timberline flume already constructed to reservoir No. 2, the force to be derived from a Pelton impact wheel, which will generate electric power to be transmitted by wire back to the big Amphitheater reservoir, or reservoir No. 8, and pump into the timberline flume. By this means there will be a capacity for pumping into the flume 5,000,000 gallons per day. A considerable portion of the general water supply already comes through this timberline flume, which was built originally rather to hold the ground against competitors for rights in the great reservoir. It was built just above timberline on the east fork of West Beaver, 1 mile west of the summit of the peak, at an altitude of 11,900 ft. above sea level. The flume is 4000 ft. long, and traverses the lowest pass between Beaver and Middle Beaver, whence it flows down the natural channel of the latter stream over the precipice to No. 2 reservoir. Below the reservoir it continues in the channel of Middle Beaver for 1½ miles, and is thence diverted through the McShane ditch and the Beaver creek pipe across the Seven Lakes divide, falling over a steep cliff 800 ft. high into the Lake Moraine reservoir. Thence again, by pipe and fall and ditch, down Ruxton cañon to Manitou, and again by pipe to the reservoir on the mesa a few miles west of Colorado Springs; thence by pipe, with a fall of 200 ft., to the hydrants of Colorado Springs. As there is a total fall of 5874 ft. from the highest reservoir to the plains, no continuous pipe of large size—at least, none built at reasonable cost—could stand such a pressure; hence the necessary and natural interruptions and breaks by intermediate reservoirs, falls, cascades, and open ditches.

Until 1878 the town of Colorado Springs had no water system. People drew their water from deep wells or open ditches. The soil under the town is so loose and porous that contamination occurred, followed by typhoid fever. The pure waters from the cañons of Pike's peak were looked to, and in 1878 a gravity system was constructed, bringing water from Ruxton creek above Manitou through 6 miles of 8-in. pipe to a reservoir on the mesa west of the town, whence it was distributed through the mains.

This supply was sufficient until 1889, when the growth of the town demanded additional flow. A 16-in. pipe was added from Ruxton creek, the waters of Bear creek were drawn into the system, and a ditch (now a pipe-line) was constructed to make the waters of Cheyenne creek also tributary. All was then supposed to be settled and safe. But in Colorado the right to take water from a stream is as much property as land ; and a large land company having prior rights on Fountain creek (to which Ruxton and Beaver creek are tributary) brought suit against the town, resulting in depriving it of all rights on these tributary creeks, the law reading that "the water of tributary streams was included in the water rights held on the main stream." (The town purchased old rights on Beaver creek for domestic purposes and rights on Fountain creek for irrigation supply, paying $70,000.) The town, therefore, had to look elsewhere for its water supply, and an original idea was conceived for a supply which would involve no litigation. The high range 10 miles west of town becomes very cold in winter. The plan was to run a flow of water by pipe or ditch over a declivity during the winter season, which would pile up a huge mass of ice that could be thawed gradually in the summer. It was called the "iceberg idea," and, as it is unpatented, may be a suggestion for other places similarly situated. Congress in 1889 granted Colorado Springs a tract of 700 acres, including the site of Lake Moraine, for reservoir purposes. This basin of 90 acres was too high up for the pollutions of civilization to settle above it. Here was a natural dam, with only a narrow and easily-repaired break in it. In the bottom of the smaller or original Lake Moraine were two powerful springs, while the immense basin adjacent could be filled by building a small dam, and thus be made to yield an ample supply. Work was accordingly begun the same year and the dam built, 385 ft. long, 250 ft. wide on the bottom, and 20 ft. wide on the top, with facing of granite 3 ft. deep on the water face and 2 ft. deep on the outer face. It has a slope of 3 to 1 on the inside, and 2 to 1 on the outside. It is an earthen dam made of clay and gravel faced with stone. The side facing the water does not start directly down, but has a step called a "berme" to accommodate the granite riprapping. As the filling in of the earth progressed, two strips of

puddling of clay were built up, which, as the clay hardens, becomes impervious. Each of these strips is 15 ft. wide and extends 14 ft. below the bottom of the dam. The dam itself rests on a bed of clay, which was pierced to a depth of 35 ft. without finding bottom. When filled, the reservoir will extend back nearly a mile, and will rise to within 7 ft. of the top of the dam, overflowing through the natural spillway. This natural waste weir is a great local advantage, allowing the water to flow off 600 ft. to one side when it reaches a certain height instead of overflowing the dam itself. The waste pipe is 280 ft. long, placed in the natural earth and buried in a bed of concrete and hydraulic masonry. At the triangle in the pipe is the valve for turning on and off the water. The cost of the dam was $22,000.

Climbing the cliff at the head of the basin of Lake Moraine, we come out on the narrow ridge called the Seven Lakes divide, 11,070 ft. above sea level, and look down on one side on the lake 1000 ft. below, and on the other to the Meadow valley and stream of Beaver creek 100 ft. below. This stream starts on the side of Pike's peak, and through narrow ravines flows down to join the Arkansas river at Cañon City. Its flow is large, clear, and constant; and, as the height of the divide was comparatively low, a ditch was constructed to bring the waters over the divide by a pipe and discharge them over the precipice into the basin of Lake Moraine. The tributary streams of Boehmer and Sackett creeks were also enlisted in the same service. The mouth of the pipe is several feet below the surface, so that it will always be filled, no matter how cold the weather and thick the ice. The cascade at the lower end of the pipe may freeze in winter and test the "iceberg idea." The pipe carries 5,000,000 gallons daily. The head of this system on Beaver creek is at an altitude of 11,800 ft. Profiting by past experience, the legal rights on Beaver creek were secured, and the legislature granted cities certain rights for taking the water from one watershed to another. This gives Colorado Springs 12,000,000 gallons per day. The present consumption is 3,000,000 gallons. The "timberline reservation act" secured the region about the peak from settlement, and protected thereby the water supply from pollution; but this did not extend to Ruxton creek, so a 16-in. pipe was laid to carry the water from a point 1 mile below Lake Moraine.

The town storage system holds 604,000,000 gallons of drinking water and 500,000,000 gallons of irrigation water. Lake Moraine contributes 492,000,000 gallons of drinking water. Its high altitude and living springs prevent it from becoming warm or stagnant.

The two reservoirs on the mesa hold 1,000,000 and 15,000,000 gallons respectively, but the principal irrigation reservoir is Prospect lake, in a natural hollow east of the town, holding 374,000,000 gallons.

There are several other auxiliary systems, not connected with those of Pike's peak. The total amount expended hitherto on the Colorado Springs water supply is $525,000.

Sunshine and rain are both needed for green grass and shady trees and bright flowers, which go with the scenery to make Colorado Springs the handsomest resort in Colorado. The climate gives too much sun in proportion to rain. The irrigation of gardens is by hose and ditch. Water also runs in ditches along the sides of the streets, keeping fresh the shade trees which so much add to the beauty and coolness of our western towns.

The time may not be far off when, owing to the rapid growth of the city, still further enlargements of the water supply may be necessary, in which case it has still the waters of the Seven Lakes and those in the great Amphitheater west of the peak, both of which could be brought, as we have shown, into the general reservoir of Lake Moraine through the medium of tunnels. There are several other small and at present isolated bodies of water in the different crater-like pits, which, under the skilful engineering of Mr. H. I. Reid (to whom the planning and engineering of the whole water system is due), could be brought into the common system.

THE MASSACHUSETTS RAILROAD COMMISSION.

By William A. Crafts.

AFTER the civil war, when railroads were being extended in every direction to meet the wants of multiplying industries and the increasing demand for intercommunication, and the dependence of numerous interests on these highways and on the manner in which they were operated was recognized more generally than while the war engrossed public attention, there arose a demand for some governmental control or supervision which should hold the corporations to a full performance of their duties and secure reasonable and equal terms and facilities to all persons. Laws had been passed regulating them in some respects, but it was left in a great measure to the discretion of the managers to determine to what extent the laws should be obeyed. The corporations had become powerful, and inconsiderate of any interests except their own. It was the privilege of parties who suffered to seek redress in the courts for violations of the law,—a process usually avoided because of expense, trouble, and delay, except in cases of great pecuniary importance. Moreover, the railroads were under certain obligations to the public, and owed certain duties, not specifically prescribed by statute, which they theoretically recognized, but for the neglect of which there was no legal penalty. Managers of railroad corporations had done some extraordinary and scandalous things, to the great damage and even ruin of the interests with which they were entrusted, as well as to the injury of the public weal. This condition of things had gone on, practically drifting, attacked at intervals through the press, and partially modified by laws, till there came at last a demand for the exercise of some authority over a business on which all other interests depended.

The railroads had their charters from the States and were under the laws of the State in which they were constructed, and to the State belonged the right and duty of supervision within its territory. It appeared to be most in harmony with the structure of our older State governments that this supervision should be exercised through a board or commission. Massachusetts took the lead in establishing such a commission in 1869. There had previously been railroad commissions in two or three States for special purposes, chiefly in relation to location and construction over highways, and with very limited powers; but Massachusetts was the first to establish a commission with authority

to exercise a general supervision of the railroads of the State. It was a commission with wide jurisdiction, extending from the financial condition of the corporation to the construction and operation of the road and its service to the public. It could investigate, report, and recommend, but it had no direct power either to enforce the laws or to compel compliance with its recommendations.

Several States soon followed the example of Massachusetts, establishing commissions for the supervision of railroads and substantially on the same model, with such modification as the existing railroad laws rendered necessary or expedient. But this model was not adapted to the transportation conditions and the temper of the people in a large part of the country. They demanded more heroic remedies for existing or alleged evils,—State control instead of State supervision. The Granger movement swept away the milder form of supervision, and the State commissions throughout the west and south have the power to control the railroads in some of their most important functions. In most of those States there have been constant friction between the commissions and the railroads, complaints of unequal service and exorbitant charges, and repeated demands on the part of individuals or sections for reduced rates or better facilities. The establishment of the Interstate Commerce Commission transferred many of those questions to that tribunal, but local questions still fret the State commissions, and neither railroads nor shippers nor travellers nor the commissions are satisfied.

In Massachusetts, however, the milder form of supervision was not changed, and for more than 25 years the commission, with constantly increasing duties and slightly added power, has continued to serve the public and the railroads. In no State during that time has there been less friction between the railroads and the public, or, on the whole, more satisfactory service by the railroads.

This condition of affairs, while not due wholly to the existence of the railroad commission, has been greatly promoted by it. The law establishing the commission was not hostile to the railroads, or unreasonably exacting ; indeed, it commanded the approval of some of the most prominent railroad managers. But at that time in Massachusetts, as elsewhere, there was considerable agitation in some communities concerning rates and facilities for freight and passenger traffic, and there were charlatans who were advocating crude and drastic measures for the reform of railroad methods and practices. The passage of the law establishing a commission, therefore, was for the moment a check to unwise and crude legislation or attempts at legislation, and, when once created, the commission itself, by argument and report and personal influence, prevented the passage of such measures.

The commission, from the character and antecedents of its members, soon gained the confidence of the public, and gradually in a great measure that of the railroad managers. The civil service of Massachusetts, especially in its higher appointive offices, has been free from the control or attack of the spoilsmen to a greater degree than in most, if not all, the other States. The members of the commission were not elected by the people, and were not representatives of a party, as in some of the States, but were appointed by the governor, not as partisans or politicians, or as a reward for party service, but on account of supposed qualifications for the place. The theory of the advocates of the commission as to its composition, though not embodied in the law, was that one member should be a lawyer, one a merchant, and one a civil engineer, and two at least of the number were the common choice of the advocates and framers of the law.

It is not the purpose of this paper to eulogize individual commissioners or to narrate their special services, but, as the first commission laid the foundations for the service and reputation of the board, it may be well to refer more particularly to its members. Mr. James C. Converse, a merchant of Boston and president of the board of trade, was elected chairman, but Mr. Charles Francis Adams, who succeeded him three years later as chairman, was from the first the leader in the commission. He had given the "railroad problem" considerable study, and was known as an able writer on railroad questions. He practically formulated the policy of the commission, marked out its work in great measure, and wrote its decisions and reports. He discussed general railroad questions with an ability that secured a reputation in the most intelligent railroad and business circles. He entertained theories with sufficient enthusiasm to try to have them put in practice, but he was a student, and did not hesitate, upon obtaining further light, to change his views. Under Mr. Adams's lead the commission was progressive, desiring that the railroads of Massachusetts should not lag behind the best roads of other States in any respect. It advocated the reform of existing bad policy or practice, and the adoption of improved methods and ideas. By investigation and discussion it aimed to educate the public as well as railroad men, and by publicity to bring public opinion to bear upon the errors and defects of railroad management, and the improvements which were desirable. Complaints and petitions were listened to and both sides patiently heard, and decisions were reached after careful weighing of evidence and without prejudice. A complete presentation of the reasons for the conclusions generally secured an acquiescence in, if not a full approval of, the decision. Pursuing such a course for 10 years, ably supported and assisted by his colleagues, who were men qualified for their position, Mr. Adams may be said to have

given the commission its direction, and in great measure to have established its reputation. It had the confidence of the public and the respect of legislators, except of that class found in all legislative bodies who consider their own uninformed snap judgment worth more than the carefully-studiedop inion of experts.

When the commission was established, none of the railroads of Massachusetts were noted for adopting improvements in construction and equipment. They were in fairly good condition in both respects, and the principal lines were above the average of the roads of the entire country. One or two were experimenting with steel rails; one only had adopted the Miller platform and coupler; none had tried air brakes. The very first year of its existence, the Revere disaster—one of the worst accidents that ever occurred in Massachusetts—gave the commission opportunity and cause to urge upon all the railroads the expediency and necessity of adopting improvements in equipment and practice which had been tested elsewhere, and the absence of which in this accident had proved so fatal to human life and so disastrous to the corporation.

From that time on the commission has earnestly and forcibly advocated the adoption by the railroads of all well-approved appliances to secure the safety of travellers, employees, and the public at large, and has presented the matters in such a light that its efforts have been endorsed and supported by public opinion, which in turn had its effect eventually on the most conservative railroad managers. Without enumerating the various improvements advocated by the commission, the following are some of the more important secured thereby at an early day: the automatic block system, continuous or train brakes, tools in passenger cars for use in emergencies, the abolition of common stoves and heating of passenger cars by steam from the locomotive, and the establishment of interlocking signals and switches at grade crossings of railroads and at terminals. Some of these, by reason of the earnest advocacy of the commission, were required by legislation subject to its approval. To the credit of some of the railroad managers of Massachusetts it may be said that, when once persuaded or required to adopt such improvements, they determined to "get the best" and made liberal expenditures in doing so.

In this connection reference may be made to the efforts of the commission to secure congressional legislation in regard to safety appliances on cars used in interstate commerce. It was evident that, owing to the interchange of rolling stock in the through traffic of the country, nothing in the way of such improvements could be accomplished by any single State. The subject accordingly was brought before the convention of State railroad commissions by the Massachusetts

commission. Through its efforts, seconded by the commissions of other States, many State legislatures adopted resolutions requesting congress to take action on the subject. This brought the matter directly to the attention of many members of congress, and interested some of them sufficiently to keep it before that body till at last, in 1893, a federal law was passed requiring, after certain dates, that all freight cars used in interstate commerce should be equipped with automatic couplers, that all freight trains engaged in interstate transportation should be equipped with train brakes operated from the locomotive, that the locomotive should have power-driving wheel brakes, and that each freight car should have hand-holds or "grab irons" for the safety of employees.

For many years previous to the establishment of the commission the railroads had been required to make annual reports of their condition and operation on blanks furnished by the State, the items in which were prescribed by law. On examination of these reports to ascertain the condition of the companies individually and collectively, the commission found, not only that their form was defective, but that they were utterly worthless for comparison of one road with another and for compilation of general results and averages. The system of bookkeeping appeared to vary according to the policy or necessities of the company. One company had been in the habit of charging new rolling stock, built or purchased to replace old, to operating expenses, so that, at a time when locomotives were costing $10,000, their locomotives stood on their books at an average cost of $2000 or $3000. Another company would adopt a policy the reverse of this, and charge to construction items which belonged to operating expenses.

It was not altogether an easy matter to reform the methods of bookkeeping which some of the old railroad officials had been following for many years. But, by changing the form of the report, and showing the unfairness of comparing results shown by different systems of bookkeeping, something was accomplished, and subsequently, under the supervision of an expert accountant, the returns were brought to a fair degree of correctness and reliability. The advantage of this is now fully appreciated by those officials who were at first loath to abandon old habits. It was an important advantage to the commission, as it gave them a fairer knowledge of the actual as well as comparative condition of the several roads, which knowledge is often of absolute importance in determining questions that arise in the performance of the duties of the office.

While the success of the Massachusetts commission is due chiefly to the legislation of the State in determining its functions, and to the character of its *personnel*, it was fortunate in the beginning that there

was not in the State any overshadowing railroad corporation to antagonize it, or any one great predominant interest opposed to alleged exactions of the railroads asking the commission to right its wrongs. At the west, where agricultural products form the great bulk of railroad freight, the agricultural interest, the consolidation of all the individual grain growers and cattle raisers into one body to which all other interests are subordinate, is a power in business, and especially in politics, which is arrayed against the railroads, whose interests are supposed to be adverse. It is not necessary to consider how much of this hostility is well or ill founded; the fact is that it exists. And that is why there were "Granger laws" in the place of railroad supervision, and a perpetual war against railroads instead of moderation and conciliation.

In Massachusetts, as in other eastern States, on the other hand, there is no one predominant interest contending with the railroads for one definite purpose,—better and cheaper facilities for transportation of its products. The only thing that partakes of that character is the manufacturing interest, which, of course, wants cheap transportation, especially for its crude materials,—cotton, wool, iron, and coal. But the manufacturing industries are so various, and the conditions under which they exist are so different, that there can be no universal demand for a uniform redress of alleged grievances. Moreover, the combined manufacturing industries furnish only a fraction of the business of the eastern railroads. The grievances as to rates are therefore individual or local, and, as such, demand special methods of redress; and to fix a uniform rate for the transportation of certain classes of freight, if not utterly impracticable in Massachusetts, would result in manifest irregularity and injustice to some of the interests concerned. Each application for a reduction of rates has, therefore, been heard by the commission on its merits, the charge generally being either discrimination or exorbitance, and, after a careful weighing of the evidence and the application of certain admitted principles, a decision has been reached and presented with such fairness and weight of argument that in most cases it has been acquiesced in by the party against whom it bore. If a railroad refused to comply in any degree with the recommendation of the commission as to rates, the aggrieved party could apply to the legislature to fix the rates. In only one case of any importance, however, has there been such refusal, and that was by a foreign corporation that operated leased roads in Massachusetts. The parties aggrieved by the railroad's refusal resorted to the legislature, and the commission by special act was authorized, after a further hearing, to prescribe the rates, which were then subject to enforcement in the courts.

The commission has never desired the power of establishing rates,

and has more than once advised against proposed legislation increasing its powers in that or any other direction in a way to disturb the natural course of business. Early in its history it found that a gradual reduction of rates was brought about by the competition of railroads, business centers, and industries, and from year to year it showed this reduction in its annual reports. Improved facilities for traffic in the way of construction and equipment, and wise economies resulting from an intelligent use of experience, were believed to produce a more natural and safe reduction, even if slower, than any governmental regulation could effect. The efforts of the commission were, therefore, directed to bringing about such improvements and economies as the true basis for the lowest paying rates.

How reduction of rates resulted, under this policy on the part of the commission, and through the natural forces of commerce and industries, may be seen by the following statement. In the first year after the creation of the commission the average freight rate per ton mile on all the Massachusetts railroads was 3.11 cents, and in 1894 the average was 1.33 cents. On two roads connecting directly with the west the rate on one in 1870 was 2.19 cents and in 1894 .94 cent, and on the other the reduction was from 4.81 in 1870 to .90 cent in 1894. The average reduction is, of course, largely caused by increased volume of through business on which the rates are exceedingly low; but the local rates have also gone down under the natural laws of trade, though they do not operate with equal force in a limited territory.

In the matter of accommodations and facilities the commission has had a great many cases which have been heard with impartiality and due regard to the condition and business of the railroad as well as the interest of the community it served. In several cases where the commission recommended new or better station buildings and the railroads concerned neglected to comply with the recommendation, recourse was had to the legislature (not by the commission, but by the parties aggrieved), and acts were passed requiring the road, under a penalty for delay, to construct such buildings as the commission should prescribe. In performing these duties the commission required only what was needed to meet the wants of the local business, present and immediately prospective, and the extravagant wishes of some of the patrons of the road were overruled. The result has been that the local communities have been fully satisfied, and the railroad managers have generally acknowledged that in these matters they have been fairly dealt with by the commission.

The Massachusetts commission has supervision of the street railways to a certain extent. It prescribes the form of the annual report

of the financial condition and operation of the railways, and the method of bookkeeping. The location of tracks and appliances for motive power is mainly under the control of municipal authorities, subject, however, in some cases to the approval of the commission. The use of electric motive power has multiplied the number of street railways all over the State, and especially in the eastern part, where the population is dense. New companies have been organized, and these consolidated with older companies connecting with them. Such consolidations offered great opportunities for stock watering and other abuses. Recent legislation, however, has provided a check to such operations. No railroad or street railway can increase its capital stock or issue bonds except with the approval of the commission; even when authorized by the legislature, new stock and bonds can be issued only under such approval of the commission, after a careful investigation of the financial condition of the companies and the purposes to which the stock and bonds are to be applied. The commission has been careful in its examinations, and fearless in condemning whatever appeared to be of questionable honesty or doubtful policy. This has proved a salutary check upon the schemes of outside syndicates or "traction companies" organized in other States to get possession of Massachusetts street railways and issue securities far beyond their value.

The Massachusetts commission has the reputation of being the ablest and most successful of the State agencies for the supervision of railroads. That reputation is due, in the main, to its able reports and discussions of railroad questions, and to the absence of any conflict between the railroads and the public. Such real success as it has had may be attributed to the following causes and conditions:

1. The railroad code of the State—in its present condition due to a great extent to the commission—was such, at the outset, as to make a commission a logical step in the administration of the laws. From the beginning of railroads the State had reserved the right to alter or amend the charters, and to subject them to all subsequent laws. The commission was therefore recognized by railroad managers, as well as by the general public, as a legitimate supplement of existing laws.

2. The theory of the duties and functions of the commission, as conceived and formulated by its early advocates and continued to the present time, was simply to ascertain and report whether the laws were obeyed, and if the roads were fulfilling their obligations to the public. By its discussion of questions arising in the performance of these duties, it was to guide, mould, or create public opinion, and bring it to bear upon railroad managers. The limitation of its powers made it more acceptable to the corporations, and eventually satisfactory to that portion of the public which desired to give it greater power.

3. The *personnel* of the commission, except for one brief period, has been free from political control or partisan appointment. The members have been men of ability, who commanded the respect of the people, and, in the main, of railroad managers. They have held the position continuously, by reappointment, for a long time, three of them until their death, and one, who declined reappointment, dying shortly after the close of his second term of 3 years. This permanence of official life has given it the advantage of continuous study and experience.

4. The conservative, careful manner in which it has heard and acted on questions arising between the railroads and the public or individuals. Much of its work has been of a judicial character, and it has maintained an impartial and dignified attitude in its conduct, and in its reports, decisions, and recommendations. It has not attempted to prescribe the duties or the policy of the railroads beyond the requirements of law fairly interpreted; nor has it hesitated to condemn what it considered unwise railroad policy or bad railroad practice.

5. The generally wise and moderate legislation of the State. This is due in no small measure to the advice and influence of the commission. By that influence some unwise, not to say foolish, projects have been kept from the statute book, and measures of good intent have been perfected. The legislature, by its committees, has fully consulted with and deferred to the commission, and, in imposing new duties on the railroads, has in many cases made them subject to the discretion of the commission.

6. The absence of any popular demand resisted by the combined railroads of the State. The questions at issue have generally been between a particular community or class and a single railroad, and, though the principles evolved might affect other communities or railroads, each case has been decided on its merits.

So long as the commission exists under these conditions, it will continue to be successful in promoting the interests of the public and the railroads. When it is made the State's agent for control or management, it will cease to be useful.

FRANKLIN LEONARD POPE.

WARM personal esteem and friendship, combined with the respect which conspicuous talent, practical ability, and rigid integrity always command, render it a grateful task to pay that tribute to the character and work of Mr. Franklin Leonard Pope, late of the staff of THE ENGINEERING MAGAZINE, for which his recent sad and sudden demise furnishes the occasion.

In a recent conversation with Mr. Pope the subject of the various forms in which death approaches was discussed, eliciting from him the expression of a hope that his own death would come by no lingering route, but quickly and painlessly. He did not fear death,—no man like Mr. Pope need fear death,—but he confessed to a dread of the suffering, often prolonged for weary months and years, through which the end of life is at last reached. To retain health and mind in full vigor till the appointed time, and then to glide out "into the unknown region where there is neither sight nor sound, nor any path to follow," seemed to him "a consummation devoutly to be wished."

He completely realized this wish. Death came to him invisibly, swiftly, painlessly, and silently,—like a chance arrow in the night,—before his physical or mental powers had known any impairment, and in, perhaps, the crowning moment of his useful career, at his pleasant home, and while surrounded with his family and all that makes life pleasant and desirable.

Born in Great Barrington, Mass., in 1840, Mr. Pope returned about 2 years ago to the place of his birth, and resided there as a distinguished and honored citizen of that beautiful town. He was the consulting engineer of the Great Barrington Electric Light Company, and—characteristically—took great interest in his work.

To afford convenient opportunity for observing the operation of the plant, he had placed in the cellar of his house the two 1000 volt converters connected with it. On the appearance of any trouble with the lights that was attributable to this part of the apparatus, it was his custom to personally make any needed adjustment. On the fatal evening of October 13 something appeared to be lacking in the operation of the converter, and Mr. Pope went down to make the adjustment. In a few moments his family, on the floor above, heard a heavy fall, and, going to ascertain the cause, found Mr. Pope dead on the cellar floor. His death seemed to have been instantaneous, and was, doubtless, without pain. It is supposed that he received a fatal shock from the current, said to have an electro-motive force of about 2000 volts.

Exactly in what way this skilful electrician, versed in all the details of electrical machinery and apparatus, and fully aware of all the danger of carelessness or inadvertence in manipulating a converter, became exposed to an electric shock will probably never be known, unless medical examination shall disclose the fact that some sudden physical disability came upon him and deprived him of the power to apply his usual care, knowledge, and prudence to self-preservation.

At the age of 17 Franklin Leonard Pope commenced his career as an electrician in the humble capacity of a learner of telegraphy in the office of the American Telegraph Company in Great Barrington, where he mastered both the Hughes printing telegraph and the Morse telegraph systems, becoming an expert operator.

At the age of 20 he came to New York, and, looking around for employment, called at the *Scientific American* office as an applicant for work. With a single exception—Horace Greeley—there probably never came to this city a talented youth less calculated by exterior appearance and cultivated manners to win favor at sight than was Mr. Pope at the time he made this application. Yet, without knowledge of the world's ways, without anything to recommend him, except a gleam of talent, which, like the glint of a diamond in the rough, revealed his true quality, the youth, in this field of push and hustle, stood his ground and made his way. He first tried his hand at drawing in the office of the *Scientific American*, but, having a native bent for writing (in after life greatly developed), the shrewd managers of that newspaper detected his latent capacity, and gave him work in the editorial department.

Near the close of the great civil war a project for uniting this country with Europe by wire, by what was styled the "Collins route" through British Columbia, Alaska, Russia, and Siberia, was projected. The Western Union Telegraph Company spent $4,000,000 toward carrying out this scheme, abandoning it when the first ocean cable demonstrated the feasibility of communication directly across the Atlantic. In the necessary surveys for this work young blood found, and seized upon, opportunity. Among others, Mr. Pope, a vigorous young man of 25, proffered his services, and obtained a position as engineer on the staff of Colonel Charles T. Bulkley, who was at the head of an exploring expedition in British Columbia and Alaska for the purpose of locating a practicable route. In this service Mr. Pope made the acquaintance of Mr. George Kennan, the author of a series of articles on Siberia, published in *The Century Magazine*, and subsequently printed in book form. A friendship formed between these comrades through two years of service and based on mutual esteem for sterling qualities which each recognized in the other, was never broken.

In 1868 Mr. Pope returned to New York and assumed the editorial conduct of the *Telegrapher*. While editing this paper, he published "Modern Practice of the Electric Telegraph," a standard treatise, without which no electric engineer's library is complete. His attention then turned to the subject of electric railroad signalling, and he engaged in the signal business, distinguishing himself by important inventions in that field.

Next the demand for electrical knowledge in the profession of patent attorney, for which Mr. Pope's analytical mind peculiarly fitted him, directed him into that occupation, and he was employed for several years as patent attorney and expert by the Western Union Telegraph Company. From this special work he entered into general practice as patent attorney and expert on his own account. This practice Mr. Pope retained, doing more or less of it as his services were in request, till his death. In 1884 Mr. Pope assumed the editorial management of the *Electrician and Electrical Engineer* (now the weekly *Electrical Engineer*).

Mr. Pope was among the the earliest to recognize promise in THE ENGINEERING MAGAZINE. Almost as soon as the first number appeared, he wrote to the editor a congratulatory letter, stating that he had read it from beginning to end with ever-increasing admiration of its contents, and a conviction that its influence would be wide and important upon the progress of the age. He shortly became, and has since been, one of its most valued contributors, and, later, he also became the electrical editor of the magazine. But his work was not wholly confined to this department. His counsel and influence have more or less pervaded all the departments of editorial work. So much has this been the case that his loss will be felt in this office perhaps as much as in any of the numerous activities which occupied his attention at the time of his demise.

In his practice as an electrical expert and patent attorney—a field of which Mr. Pope was among the first to make a specialty—he acquired the enviable reputation of strict rectitude and reliability. No inducement, financial or other, could induce him to lend himself and his abilities to the support of what he believed to be injustice. An expert witness who would directly or indirectly testify in support of anything he believed to be false was considered by Mr. Pope as a perjurer, in as strict a sense as any common witness who testifies falsely to material facts. Large retainers have been repeatedly refused by him on the ground that he could not conscientiously testify to opinions that he did not fully hold. He was retained in many important patent suits by such litigants as the Bell Telephone Company, Western Union Telegraph Company, Westinghouse Electric Company, etc.

On account of his inflexible honesty he was rarely put on the witness stand, although his testimony, given on any vital point, was always regarded with respect by both sides in a controversy.

Mr. Pope was singularly fond of investigating the history of electrical progress and of electrical inventions and discoveries. Few men of his time knew more of such things than he did, and he might have done the scientific world a lasting service by writing such a history up to date. He had devoted special attention to the work of Henry, Morse, Vail, Thomas Davenport,—the Vermont blacksmith who in an operative model constructed the first electric railway,—and House and Bain, who, after Morse, did pioneer work in telegraphic improvements. He contributed to the electrical press, as opportunity offered, in vigorous, terse, and graceful style, many interesting papers on the work of these men, and upon other topics related to the early history of electrical engineering.

He was also thoroughly informed upon the early history of Massachusetts, particularly of the Berkshire region, where he was long favored with the intimacy of Cyrus W. Field and other members of the distinguished Field family.

The general honor and esteem in which Mr. Pope was held caused him to be named for, and elected to, the presidency of the American Institute of Electrical Engineers in 1886, succeeding in that office Dr. Norvin Green. He was one of the charter members of this society. He was also a member of the British Institution of Electrical Engineers.

One of his latest works was the superintendence of a change in the electric-lighting plant of Great Barrington, involving the abandonment of steam power and the utilization of water power obtained at a point some 5 miles distant. A full account of this important work was given in an engineering paper presented at the meeting of the American Institute of Electrical Engineers at Niagara Falls, last June.

And now, for our friend, efficient helper, and wise counsellor, who has closed his mortal career, let us say a few words that shall, if possible, impress upon the minds of those who had not the privilege of intimately knowing him something of his personality.

Mr. Pope was of strong, large, physical frame, "square faced and massive," as his portrait indicates. He was a most industrious worker, enduring his work well, because he loved it. His bearing was unassuming, and, though a master in his profession, nothing ever escaped his lips that betrayed egotistic pride, or a contempt for lesser attainments, unless these were made the fit subject for contempt by an offensive assumption of learning. He was kind and obliging in disposition, and ever eager to assist a friend. His large fund of informa-

tion, his extensive reading, his strong sense, his habit of thinking down to the bottom of subjects, and his varied experience in life rendered him a most interesting companion, and personal intercourse with him was extremely agreeable.

His truthfulness was manifest in all that he did or said. He never, even by implication, made any pretence of knowing anything of which he was not accurately informed; and, when he made promises, he kept them, even at the expense of needed rest.

As a writer upon his favorite topics, he stood in the first rank. His acute mind seized readily and easily upon points of weakness in a controversy, and he did not let them escape; yet his criticisms were mild in form, and not intended to inflict pain. He was one of those rare men who can differ radically in opinion from their opponents, without incurring enmity.

In an interview held on the morning when the New York papers announced the death of Mr. Pope, Mr. T. Commerford Martin, editor of the *Electrical Engineer*, said: "Mr. Pope was one of the few remaining men of the earlier school who, graduating from the telegraph key, had kept in touch with all the later developments of electricity, and had made their mark in each new field as it developed. The art now differentiates so rapidly that the modern electrician tends more and more to become a specialist. In this respect Mr. Pope might well be spoken of as the Nestor of telegraphic electricians."

Mr. Pope leaves a wife, two daughters, and one son. Two brothers are also noted electricians. Mr. Ralph W. Pope is secretary of the American Institute of Electrical Engineers, and another brother, Mr. Henry W. Pope, is an electrician in the service of the American Telephone and Telegraph Company, New York city.

Both the daily and technical press have honored the memory of Mr. Pope by profuse notices, and comments upon his ability and nobility of character; and we shall ever regard as one of the most pleasant of life's memories his association with the editorship of this magazine.

REVIEW OF THE INDUSTRIAL PRESS

WITH AN INDEX TO THE ENTIRE RANGE OF AMERICAN AND ENGLISH ENGINEERING LITERATURE.

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THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles of the month which are deemed of most importance; (2) to supply a carefully classified Index to *all* the leading articles published currently in the scientific and industrial press of the United States, Great Britain and the British Colonies; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

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Electrical Plant. *m.* 6*s.* London.
Electrical Review. *w.* 21*s.* 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24*s.* London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7*s.* 6*d.* London.
Engineer, The. *s-m.* $2.50. New York.
Engineer, The. *w.* 36*s.* London.
Engineer & Contractor. *w.* $1. San Francisco.
Engineering. *w.* 36*s.* London.
Engineering and Mining Journal. *w.* $5. N. Y.
Engineering Magazine. *m.* $3. New York.
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Engineering Review. *m.* 7*s.* London.
Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
Fairplay. *w.* 32*s.* 6*d.* London.
Fire and Water. *w.* $3. New York.
Forester, The. *bi-m.* 50 cts. May's Landing, N.J.
Fortnightly Review. *m.* $4.50. London.
Forum, The. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4. New York.
Gas Engineers' Mag. *m.* 6*s.* 6*d.* Birmingham.
Gas World, The. *w.* 13*s.* London.
Geological Magazine, The. *m.* 18*s.* London.
Heating and Ventilation. *m.* $1. New York.
Ill. Carpenter and Builder. *w.* 8*s.* 8*d.* London.
Improvement Bulletin. *w.* $5. Minneapolis.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Industry. *m.* $2. San Francisco.
Inland Architect. *m.* $5. Chicago.
Inventive Age. *s-m.* $1. Washington.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30*s.* 4*d.* London.
Iron & Steel Trades' Journal. *w.* 25*s.* London.
Iron Industries Gazette. *m.* $1.50. Buffalo.
Iron Trade Review. *w.* $3. Cleveland.
Journal Am. Chemical Soc. *m.* $5. Easton.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal Franklin Institute. *m.* $5. Phila.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6*s.* London.
Journal of the Society of Arts. *w.* London.
Locomotive Engineering. *m.* $2. New York.
Lord's Magazine. *m.* $1. Boston.
Machinery. *m.* 50 cts. New York.
Machinery. *m.* 9*s.* London.
Manufacturer and Builder. *m.* $1.50. New York.
Manufacturer's Record. *w.* $4. Baltimore.
Marine Engineer. *m.* 7*s.* 6*d.* London.
Master Steam Fitter. *m.* $1. Chicago.
McClure's Magazine. *m.* $1. New York.
Mechanical World. *w.* 8*s.* 8*d.* London.
Metal Worker. *w.* $2. New York.
Milling. *m.* $2. Chicago.
Mining and Sci. Press. *w.* $3. San Francisco.
Mining Industry and Review. *w.* $2. Denver
Mining Journal, The. *w.* £1. 8*s.* London.
Mining World, The. *w.* 21*s.* London.
National Builder. *m.* $3. Chicago.
National Car Builder. *m.* $2. New York.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50. London
North American Review. *m.* $5. New York.
Paving & Munic. Eng. *m.* $2. Indianapolis.
Plumber and Decorator. *m.* 6*s.* 6*d.* London.
Popular Science Monthly. *m.* $5. New York.
Power. *m.* $1. New York.
Practical Engineer. *w.* 10*s.* London.
Proceedings Engineer's Club. *q.* $2. Phila.
Progressive Age. *s-m.* $3. New York.
Railroad Car Journal. *m.* $1. New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7*s.* London.
Railway Review. *w.* $4. Chicago.
Railway Times, The. £1. 5*s.* London.
Railway World. *m.* 5*s.* London.
Review of Reviews. *m.* $2.50. New York.
Rhodes' Journal of Banking. *m.* $5. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10*s.* London.
School of Mines Quarterly. $3. New York.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York.
Scientific Am. Supplement. *w.* $5. New York.
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scientific Quarterly. *q.* $2. Golden, Col
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, New York.
Social Economist. *m.* $2. New York.
Southern Architect. *m.* $2. Atlanta.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago.
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Am. Ins. Electrical Eng. *m.* $5. N. Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York.
Transport. *w.* £1. 5*s.* London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $4. Butte, Mon.

Austrian Floor Tests.

THE tables herewith presented constitute a valuable addition to architectural and engineering data. They are a part of the report of the arch-tests committee of the Austrian Society of Engineers and Architects, which has appeared in the *Zeitschrift* of the society.*

The report covers: (1) tests of seventeen floor arches with spans of 4 ft. 4.3 in., 8 ft. 10.2 in., and 13 ft. 3.6 in., representing all kinds of floor construction; (2) tests of two culverts of 32.8-ft. span and 1-10 rise; (3) tests of four bridges of 75 ft. span and 1-5 rise; (4) an exhaustive series of tests to determine the strength and elasticity of all materials used in the above arches; (5) a theoretical calculation based on the results attained; (6) conclusion from the result in regard to theory and construction.

In reprinting the report for wide circulation, the object of the society is to bring about desired improvements.

All the tests were made under the strict supervision of the most prominent engineers to insure conformity to usual practice, while the theoretical work was so divided up that each part fell to an expert. A full record of deflection and other details is given. Table I, as herewith presented (span 4 ft. 4.3 in.), includes results for floors in common use. Results for patented floors, also given in the report, are omitted from this review.

Hollow tile arches of the American type are entirely unknown in Central Europe. The floors were intended for a live load of 120 lbs. per sq. ft. The tie-rods were constructed for a test load of 1000 lbs. per sq. ft., at which point they were at a tension of 15,000 lbs. per sq. in. Tests were stopped at 1638 lbs. per sq. ft., because the corresponding safety was more than sufficient and the tie-rods were then strained to their elastic limit, so that a continuation would have resulted rather in a test of the tie-rods than of the floors; up to this load no sign of failure appeared.

TABLE I.—SPAN 4 FT. 4.3 IN.

	Brick Arch.			Hollow Brick Arch		Concrete Arch	
	Thickness .... 5.91″ Rise .... 5.71″ Dead load, 70 lbs. per sq. ft.			Thick., 5.91″ Rise... 4.92″ Dead load, 75 lbs. per sq. ft.		Th'k., 2.93″ Rise. 4.53″ Dead load, 91 lbs. per sq. ft.	
No.	Load Per sq. ft.	Movt. of Arch. Vert	Lat.	Movt. of Arch. Vert.	Lat.	Movt. of Arch. Vert.	Lat.
1	102	0.02		0.04		0.01	
2	205	0.03		0.08		0.09	
3	307	0.06		0.14		0.15	
4	409	0.09		0.20		0.21	
5	512	0.13		0.27		0.25	
6	614	0.17		0.35		0 30	
7	716	0.22		0.39		0 35	
8	819	0.26		0.45		0.40	
9	921	0.31		0.52		0.44	
10	1024	0.37		0 58		0.47	
11	1126	0.41		0 63		0.53	
12	1228	0.46		0.72		0.59	
13	1331	0.50		0 83		0.64	
14	1433	0.55		0.95		0.68	
15	1436			0.95		0.68	
16	1536					0.72	
17	1638	0.22		0.65		0.77	
18						0.76	

Remarks.—The brick arch developed a crushing crack at test No 7; its joints opened at No. 11; at No. 13 there were two cracks in brick. In test No. 18 the arch remained perfect. The hollow brick arch showed openings in joints in test No. 7, and at No. 12, there was a crack in the brick. In test No. 18 the arch remained perfect. The concrete arch cracked in the cetner at No. 3, and a second crack at No. 7.

The concrete arch (1:5), although but half as thick as the brick arches, showed, on the whole, as good results, and consequently is well fitted to replace them.

The conclusion derived from results indicated in Tables II and III are: (1) brick arches of the thickness given by the size of brick manufactured show the extreme permissible limit of span to be 8 ft. 10.2 in.; (2) concrete arches (1:4) show in both cases adequate dimensions; (3) the Monier arch, with one wire net, has failed to show

* This report has been reprinted in book form, and may be obtained from Mr. Fr. Von Empenger, consulting engineer, 72 Broadway, New York. Price, postage prepaid, $2.65.

TABLE II.—SPAN 8 FT. 10.2 IN.

	Concrete Arch.	Monier Arch.	Mon. Arch, concrete floor.	Brick Arch.	Hollow Brick Arch	Corrugated Iron.	Corrugated Iron reinforced with angle irons.
	Thickness. ... . 3½″	Thick., 1⅛″	Thick., 2½″	Thick., 5½″	Thick.. 3⅛″	3.5″x1.9″x .039″	Th. 2 36″x2.36″
	Rise. ... ...9.5″	Rise...10⅛″	Rise... 10⅛″	Rise... 9.85″	Rise, . 5⅛″	Rise. . . 9.85.	Rise .... 10¼″
		Dead load..	Dead load..	Dead load	Dead load..	Dead load ...	Dead load. ..
	Dead load. .. . .3140 lbs.	.. 2460 lbs.	.. 5420 lbs	.. 2680 lbs.	.. 1191 lbs	.. 143.5 lbs.	.....198.5 lbs.

No.	Load Per sq. ft.	Movt. of Arch.		Movt. of Arch.		Movt. of Arch.		Movt. of Arch.		Movt. of Arch.		Movt. of Arch.		Movt. of Arch.	
		Vert	Lat	Vert.	Lat.	Vert.	Lat.	Vert.	Lat.	Vert.	Lat.	Vert.	Lat.	Vert.	Lat.
1	102	.04	0.008	.04	.01	.03	.004	.07	.016	.05	.008	.11	.02	.17	.01
2	204	.09	.015	.08	.02	.07	.008	.19	.06	.37	08	24	02	.31	.02
3	307	.17	.04	.16	.04	.13	.02	.33	.10	74	.15	.35	.03	.38	.03
4	409	.24	.07	.24	.06	.19	.03	.51	.16	1.44	.29	.45	.04	.46	.04
5	512	.33	.11	.34	.08	.28	.05	.77	.21			.60	.05	.53	.06
6	614	.42	.16	.43	.11	.37	.07	1.08	25			74	.07	.62	.07
7	716	.53	.20	.55	.13	.43	.10	1.47	.31			.90	.09	.71	.08
8	819	.64	.25	.67	.17	.56	.14	2.07	.39			1 06	.12	.81	.09
9	921	.79	.31	.83	.22	.71	.18							.97	.10
10	1024	.95	.38	1.01	.28	86	.23							1.15	.12
11	1126					1.03	.29								
12	1331					1.21	.35								

Remarks.—At No. 2, for the concrete arch, a horizontal fissure in the unloaded half occurred. In No. 6, for the same arch, a crack at the abutment occurred. This arch totally failed at 1109 lbs. per square foot, one-half of the arch being loaded. At No. 10, for the 1 15-16″ Monier arch, failure occurred with 1217 lbs. per square foot, one-half of the arch being loaded. At No 10 of the 2 1-8″ Monier arch, a longitudinal crack appeared. This arch failed with eccentric load of 1320 lbs. per square foot. At No. 7 of the 5 1-2″ brick arch test a horizontal fissure occurred in the unloaded half; this arch failed under an eccentric load of 885 lbs. per square foot. At No. 2 of the hollow brick arch, a crack in the unloaded half, 9.85″ from the crown, occurred. The arch failed under an eccentric load of 401 lbs. per square foot. The corrugated iron arch failed under an eccentric load of 975 lbs. per square foot, the ends being very much bent and injured. The corrugated iron arch, reinforced with angle irons, failed under an eccentric load of 1099 lbs. per square foot.

TABLE III.—SPAN 13 FT. 3.6 IN.

	Monier Arch.	Concrete Arch.	Brick Arch.	Melan Arch 13′ 11″ Span.
	Thickness . ... 1½″	Thickness .. .. 3⅛″	Thickness..... .. 4⅞″.	Thickness..... ... 3½″
	Rise .... 15½″	Rise ... ... 15⅞″	Rise .... 13.8″	Rise .... 11.4″
	Dead load of arch..... 2215 lbs	Dead load of arch ... ... 4420 lbs	Dead load of arch, not given.	Dead load of arch.... 4860 lbs.
	Dead load of filling.... 4160 lbs	Dead load of filling ..... 4560 lbs	Dead load of filling. not given.	Dead load of filling ..... 1549 lbs.

No	Load Per sq. ft.	Movt. of Arch.		Movt. of Arch.		Movt. of Arch.		Movt. of Arch.	
		Vert.	Lat.	Vert.	Lat.	Vert.	Lat.	Vert.	Lat.
1	102	.02	.01	.01	.0	.15	.05	.05	0.0
2	205	.05	.02	.03	.004	.30	.11	.09	.004
3	307	.10	.04	.07	.02			.14	0.02
4	409	.15	.07	.11	.04			.19	0.04
5	512	.24	.11	.17	.07			.21	0.07
6	614	.33	.16	.21	.14			.25	0.08
7	717	.40	.23	.23	.18			.42	0.12
8	819	.77	.31					.54	0.15
		1.08	.39						
9	1024							.58	0.11
10	1028							.67	0.09
11	1412							.80	0.05
12								0.3	0.02

Remarks.—The 1 15-16″ Monier arch, at No. 4, developed a crack at the abutment, and, at No. 5, a second crack in the unloaded half. At No. 8, the movement indicated took place under 822 lbs. And at No. 9 the arch failed, after 2 1-2 hours, under 895 lbs. per square foot, including dead load. The concrete arch developed a crack at No. 4, through the entire length of the arch, at the abutment. The movement indicated at No. 7 for the concrete arch took place under 662 lbs. This arch failed under 812 lbs. per square foot, including dead

the superiority claimed for it, which is the more significant because the Monier arch has been, up to date, the most favored type of fireproof construction in Central Europe.

The report disapproves the use of a concrete floor with the Monier netting, as it needs 1.85 times more concrete and gives only a trifling increase in strength, so that dirt filling, which is more economical, is preferable. Referring to the fact that both concrete arches, with or without wire netting, have shown almost the same behavior, the report further says: "Compared with a plain concrete arch, a concrete arch with one wire netting has shown but little more carrying capacity, so that the difference cannot have any importance to the ordinary building practice." It is also concluded that a little thicker concrete arch may replace it. "To understand this condemnation of the Monier arch, it must be considered that, besides the wire netting, it is composed of a more expensive concrete,—to wit, mortar 1:3. Engineers have for a long time recommended Monier arches with two wire nettings for large spans, as it is evident that wire is needed on both sides of the arch and not in the center, but it is nearly impossible to use two nettings in a small span. This point has been fully justified by the test of the Monier arches with two nettings of a span of 75 ft. and 15 ft. rise, which may be well to insert here, so as not to make a faulty impression. The failure occurred under a one-sided load."

Material.	Thickness. Center.	Haunches.	Breaking load per sq. ft.
Brick	2 ft.	3 ft. 6 in.	590 lbs.
Stone	2 ft.	3 ft. 6 in.	655 lbs.
Concrete	2 ft. 3 in.	2 ft. 3 in.	735 lbs.
Monier, 2 nets	1 ft. 1 in.	2 ft.	1300 lbs.

The Melan arch is a direct outcome of these tests and their results, and was not placed before the committee until more than a year afterwards. It does away with the cross-rods, places the iron at the surface on both sides of the arch, and allows the use of concrete, instead of mortar, as required with the wire netting. Wire netting interferes with the placing and ramming of concrete, as special appliances are needed to hold the netting in place before enclosing it in concrete. The Melan arch was built of 1:5 concrete and three 15-in. I-beams, 39.4 in. apart. The report states: "From the behavior of this construction, there is no doubt that these vaults have a far superior carrying capacity than either the plain concrete or the Monier arch," etc.

Architectural Training.

THE School of Architecture and Applied Arts at Liverpool was inaugurated May 10. An address delivered on that occasion by Mr. T. G. Jackson, A. R. A., and published in the *Journal of the Royal Association of British Architects* (Aug. 22), makes a strong plea for education of architects on broader lines, and points out defects in the present system of office-training, which isolates the architect too much from sister arts.

The school named is intended to give its pupils an elementary practical knowledge of the handicrafts involved in architectural construction, as well as esthetic principles,—of practical construction, as well as the arts of design. In this respect it is an experiment in architectural education the results of which are yet in the future. "Indeed, the whole system of teaching crafts of any kind in technical schools is still in an experimental stage, and we are still in the dark as to what will come of it. In the handicrafts it seems to have sprung into existence to fill the void left by the decay of the old system of apprenticeship. Trades were learned in olden time, and down to our own day, by binding lads to serve under an experienced

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load. The brick arch developed a crack at test No. 2 in the upper surface of 1-4 unloaded arch, at 137 lbs. per square foot and collapsed under 274 lbs. per square foot, including dead load. The Melan arch of 3 1-8″ thickness developed, at test No. 10, a hair crack on the under side of the arch about 11′ 8″ long, visible near the crown; this crack did not widen later, after a pause of 18 hours. The lateral deflections to the right are recorded in the negative.

master, who undertook to impart to them the mystery of his craft. Why this system has fallen suddenly into disuse we must not stay to inquire; enough that it has done so."

The system of apprenticeship is, however, still retained in architecture. "It is still thought a necessary part of the training of an architect for his calling that he should be apprenticed to a practising architect, and learn from him how buildings are designed and carried out. Of course, no one supposes that he can get all his training in that way. He must read for himself, and study for himself as well; he must form his taste by observation of other men's work, both modern and ancient, and he must take every opportunity of being on the works that are going on under his master's direction, so as to see in process of execution the designs which he has known, and perhaps himself worked out on paper. But if he chooses his master wisely, and if the master acts conscientiously by him, that part of his training which will most influence his after-career is that which he gets in his master's office. No training in schools will ever give him the same insight into the proper conduct of an architect's work, nor will any amount of exercises in working samplers, as they may be called, teach him a tithe of what he learns from work to which responsibility is attached,—work that has really to be carried out, work that is intended to endure for generations, and which must therefore be right, sufficient, and practicable, under the penalty of failure and retribution."

For these and other reasons given at length, Mr. Jackson believes the system of apprenticeship in architecture should be retained, and the deficiencies of office-training supplied, not only by reading, private study, and travel, but by technical training in schools like that inaugurated at Liverpool. There is a danger, however, that such schools will come to be relied upon too much, and that their tendency will be to belittle the value of office-training. This can be guarded against by so framing the courses of instruction as not to supersede practice in the office.

Neither the one or the other system of training can "give the student all he wants to qualify him for his career. . . Either will need to be supplemented in a thousand ways, many of which the student must discover for himself, and will go on discovering to the end of his life." Schools like the one under consideration may be great helps, if they do not assume to teach that which can not be taught adequately in schools,—a tendency which should be combatted in all technical schools.

Modern architects work under conditions very different from those of ancient times. "While the modern architect resembles a professional man, and designs his buildings on paper, and directs them from a distance, only visiting them personally for a few hours at a time and at considerable intervals, the ancient architect lived on the building, worked on it with his own hands, and designed it in the actual material, with no drawings to speak of, and with such setting out only as could be done in the mason's shed or on the walls and floors. The modern buildings, in fact, are designed on paper; the old were designed in brick and stone and timber.

"Now, the advantages of the ancient method are obvious. Success in architecture, sculpture, and the applied arts, as they are called, depends on the right treatment of material no less than on brilliancy of design. Material must be used to the greatest economical advantage; it must be used strictly in conformity to its natural properties; the design must express those properties so clearly that it would lose its charm if translated into a different material; no matter how beautiful the design, it becomes bad art, if it is unsuitable to the material employed."

The incongruities and absurdities in the treatment of materials which mar the architecture of so many modern buildings are attributed to the fact that a large proportion of practising architects are "trained on paper only." This fact must be faced and a remedy for it sought, and the establishment of a school of architecture and applied arts is an attempt at finding such a remedy. Whether it alone will prove adequate Mr. Jackson appears to

doubt, but he appears to be equally certain that it is an effort in the right direction.

Mathematics and Construction in the Ecole des Beaux-Arts.

In a paper by James A. White, assistant professor of architecture in the University of Illinois, published in the *Technograph* and reprinted (Sept. 14) in *American Architect*, the course in mathematics and construction in the above-named famous school is described. The information thus given will be interesting to many young men who anticipate a course in this school, or who, at least, would like to take the course if means and opportunity were afforded to them. Only a bare outline will be attempted in this review.

Instruction is given entirely by lectures, 1 hour in length. The examinations are oral, but are supplemented by problems worked "*en loge*," which means that the student is assigned to an alcove and required to work out a problem in a specified time, varying usually from 6 to 12 hours.

All subjects are taught solely from the standpoint of their application to the study and practice of architecture. About thirty-six lectures are given in mathematics, including algebra, trigonometry (comprising the solution of plane triangles, calculations by logarithms, and the relation between a plane in space and its projection), conic sections (mainly confined to a careful study of curves resulting from the intersection of a cone and cylinder by a plane, drawing such curves and their tangents, and measurement of surfaces and volumes), analytical geometry (taught mainly for its application to the curves of flexure of beams), and mechanics (comprising only statics and simple machines).

Both written and oral examinations are required. Professor White says that, "though the French seem to have found the course sufficient to answer the actual needs of an architect, the American practice of adding a little more for the sake of the mental drill is a most excellent one." The course in descriptive geometry is, however, very complete, comprising fifty to sixty lectures, "of which about ten are a review of the part required for entrance and ten on the finding of common shadows." "The best conception of the course is to be obtained from the examination questions, a list of which, divided into six series, is furnished to the students. The oral examination, part of which comes at the middle of the course, is on questions from this list, one being chosen at random from each series. The first series contains about twenty-five questions on the line and plane; the second thirty on the sphere, cone, and cylinder of revolution, problems of angles, the solution of trihedral angles and regular polyhedrons; the third, thirty on cones, cylinders, pyramids, and prisms; the fourth, twenty-two questions on surfaces of revolution; the fifth, twenty-five on ruled and helicoidal surfaces; and the sixth, twenty-five on shadows.

"Twenty-two plates of about forty of these problems must be drawn, and constitute part of the examination. The problems on the first six plates are to be chosen from the first two series, on the second six plates from series three, four, and five, and the remaining ten on shadows.

"One problem must be drawn '*en loge*,' for which 6 hours is allowed. The problem given last year was: 'A cube stands with its diagonal vertical; a second cube of the same size has its diagonal coinciding with the first, but is turned through an angle of 22½°; draw in plan and elevation the intersecting cubes, and find the shadows at 45° on the solid and on the plane of projection.' Pillet's text-book on descriptive geometry is closely followed in the lectures."

The course in stereotomy is also very thorough, "and includes all of Pillet's text except the skew arch." Twenty lectures are given on theoretical construction, and thirty on technical construction, following the text of Brun in outline and "in a condensed form with demonstration of formulas." Seven lectures and 3 days' practical field work are given in surveying.

"The course in perspective consists of twenty lectures, and is very thorough. Three problems are required, besides one *en loge*. The following may be considered as samples.

"'Design a pedestal bearing a statue, the base to be about 1.5 meters across, and either square or circular. Make a drawing of a public place, surrounded by arcades and with a monumental fountain in the center. No side of the square is to be parallel to the picture plane.'

"'Make a drawing from nature of an *ensemble* or architectural detail, the drawing to be at least 0.25 × 0.35 meters.' The problem given last year to be drawn *en loge* was the capital, architrave, and frieze of the Greek Doric Order without triglyphs. The shadows were also required." "The feature of design enters every problem that requires drawing, no matter what the study."

Architecture at the Seaside.

MR. HOWARD CROSBY BUTLER, in *The American Architect* (Sept. 21), discusses American seaside architecture, in which he finds many defects. He holds that the seashore demands a "unique treatment of architecture," supporting the contention by the allegation that "in all periods, throughout all lands, and in all styles, a strict relation has been preserved between architectural forms and topographical characteristics." Now, it is not logical to deny in one form that which one has asserted in another form; yet this Mr. Butler appears to do almost immediately.

"It would be impossible to find, in the whole world, greater opportunities for the display of taste, more varied natural conditions of scenery and climate, than are afforded by our Atlantic sea-board from the rugged coast-line of Maine, along the bluffs and headlands of Massachusetts and Rhode Island, to the level shining sands of Long Island and New Jersey's sandy beach and smooth green meadows. Yet there is no place where one sees the unwritten law more frequently fractured, no place where incongruity and discord have been more firmly combined to do violence to the sensibilities of the unoffending observer, than at our seashore resorts.

"It is not difficult to find the reason for this. In the search for a suitable style much originality has been shown, and this is highly commendable. Our seashore resorts are new and very different from those of the Old World, and we want a new original style. But, unfortunately, so great is the originality that no considerable number of architects have shown the slightest agreement of ideas on the subject; the result is, therefore, far from satisfactory."

The author thinks we could benefit by imitating, or at least by the influence of, English and French watering-place architecture, "the coast of England and France being not unlike our seaboard." Along a coast more or less uneven, where sea-frontage is not the main feature, as at Bournemouth or at Etretat, a somewhat irregular style prevails. The houses have more the character of the typical villa than our own have. People who can afford it have sufficient space about their houses to give them a good setting of lawn and trees, and to have the stables inconspicuously situated at a distance from the house. The house itself is large, simple, and picturesque in design. It shows no striving after conspicuousness, but rather after elegance. Even the wealthiest abroad build houses of a modest style, making up for richness and display in simplicity and taste.

Stone and brick are the usual materials for buildings at English and French watering-places. "A marble palace in the style of Michael Angelo is seldom seen by the sea. It would rather offend a Frenchman's taste. Such a building might be suitable beside the blue of the Mediterranean, under the Italian sky, with a background of dark ilex groves and other classic surroundings, but by the gray-green of the Atlantic, beneath a cold northern sky, and with little verdure not parched and brown, the classic porch would seem rather far from home."

Studies in seaside hotel architecture may be found on "the graded and terraced shores at Brighton and Torquay"; and of residences and cottages, not only at these celebrated watering-places, but also at Cabourg and Houlgate, where are both wood and brick examples worthy of consideration. In these examples will be found a

marked contrast to what Mr. Butler calls "the overwhelming extravagance of American seaside architecture," in which "every man's house is literally his castle. Huge mansions of baronial style are crowded upon little lots in rows suitable only for modest cottages. It is the pitiable, insane desire in Americans to make a costly display, lavishing expense upon the house and taking little thought about the land; but the display here is simply a foolish waste, for a manor-house without its park loses all its dignity, and castles in rows are absurd. The same extravagance is seen in these very forms of architecture. Towering structures, with steep, broken roofs, all pinnacles and turrets, with oriel-windows and overhanging balconies, are typical of rugged mountain scenery, where peaks pierce the clouds, and crags stand out in bold relief. But beside the sea, where the level line of the horizon is the characteristic feature, a stretch of sand or a line of bluffs and green fields making up the scenery, a long, low structure, sloping roofs, and broad verandas, and, above all, plenty of space, seem much more compatible with the surroundings."

Want of harmony, juxtaposition of incongruous styles and colors, etc., are other criticisms of American seaside architecture, of which the truth is felt when one recalls to mind, and forms a mental picture of, almost any popular American seaside resort.

Concrete Floors.

AN abstract of an article by Mr. George H. Blagrove in the *Contract Journal* (*The Canadian Architect and Builder* for Sept.) represents theoretical and practical views upon a subject of growing importance, as the use of concrete for floors is constantly extending.

The concrete referred to is composed of Portland cement and some sort of aggregate, as sand, gravel, comminuted stone, etc. The author advocates the use of cement of greater fineness than has been commonly used for this purpose, but appears to think it useless to insist on any degree of fineness greater than that which rejects 12 per cent. when sifted through meshes of two thousand five hundred per square inch; at any rate, this is the fineness assumed in his discussion of mixtures, and he further assumes that the cement will "weigh at least 112 lbs. per striked bushel, or about 90 lbs. per cu. ft., and that a briquette of neat cement will have an ultimate tensile resistance of 400 lbs. per square inch after 6 days' immersion in water. To prevent any possibility of using while hot, and so rendering the floors liable to crack after setting, keeping for a month or 6 weeks after mixing, and spreading out and turning over upon a floor during the last 2 or weeks," is a course recommended.

Supposing the ingredients to be thoroughly mixed, we should obtain a concrete upon which some reliance could be placed for its resistance to transverse stress. But thorough mixing embraces the requirement often insisted upon,—that every particle of sand and coarse aggregate shall be completely coated with cement. If there be an absence of cohesion in any part of the mass, all calculations of strength may be at fault.

The question of the nature and proper proportions of the ingredients for making Portland cement concrete is, indeed, a wide one. As bearing upon the construction of floors, valuable information is afforded by the results of Mr. Darnton Hutton's experiments, described in course of the discussion of Mr. John Grant's paper on "Portland Cement" at the Institution of Civil Engineers. Mr. Hutton experimented with bars of concrete 4 ft. long and 1 ft. square, supported upon a 3 ft. span and broken by means of a load hung from the center. The general proportions of cement to other materials was 1 to 9, though sometimes higher. With 1 part of cement, 5 parts of shingle, and 4 of sand, the central breaking weight was 2656 lbs. With 1 part of cement, 5 parts of shingle, and 3 of sand, or a proportion of 1 to 8, the breaking weight was increased to 3023 lbs.,—an increase of about 14 per cent. But, on reverting to the proportion of 1 to 9, with only 9 parts of shingle to 1 of cement, the breaking weight was increased to 9590 lbs.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Architecture and Building in the American, English and British Colonial Technical Journals—See Introductory.

*1300. Contemporary English Architects and Their Work. Ill. H. Heathcote Statham (Showing, by a review of individual careers, that modern English architecture is equal to any, except in the designing of the largest public buildings). Eng Mag–Nov. 3400 w.

1310. Moving a Factory Building. Ill. (Describes the removal of a three-story factory building 350 ft. long and 50 ft. wide to a new site 300 ft. distant, without interrupting work in factory, except on first floor). Lord's Mag–Sept. 700 w.

1372. Dwelling Houses in Munich. Andrew T. Sibbald (Descriptive and interesting. The chief point of distinction between the houses is their age). Arch & Build–Sept. 14. 3300 w.

†1374. Convention Halls. Dankmar Adler (Experience of the author in the construction of such halls). In Arch–Sept. Serial. 1st part. 2200 w.

1376. Mathematics and Construction in "The École des Beaux Arts." James M. White (Published in the Technograph. A description of these branches of work in the school). Am Arch–Sept. 14. 2500 w.

†1472. Some Thoughts on the Training of Architects. An address delivered by Mr. T. G. Jackson, at the inauguration of the School of Architecture and Applied Arts, Liverpool (Architecture defined as good construction inspired from first to last by an artistic motive. The artistic motive is treated as instinctive. The topics of apprenticeship, defects in office training, ancient and modern architects, isolation of the architect from other arts, the study of the history of architecture, and the advantages of a school open to all concerned in building of whatever degree, are discussed felicitously and ably). Jour Roy Inst of Brit Arch–Aug. 22. 9000 w.

*1486. The Empress Theatre. Ill. (Descriptive). Eng, Lond–Sept. 13. 1400 w.

*1535. Some account of Concrete Construction in America (Description of the invention of Ernest L. Ransome, with comments). Builder–Sept. 14. 2800 w.

1560. Architecture at the Seaside. Howard Crosby Bates (Points out the causes of inharmoniousness, and gives useful suggestions). Am Arch–Sept. 21. 1500 w.

*1562. Concrete Floors. George H. Blagrove (The capabilities of the material and the best means of turning those capabilities to advantage). Can Arch & Build–Sept. 1300 w.

*1649. The Walls of Avignon. Ill. (Historical and somewhat descriptive). Arch, Lond–Sept. 20. 2000 w.

1650. Collapse of the Coliseum (Destruction of a mammoth pleasure palace in Chicago, with probable causes). Am Arch–Sept. 28. 600 w.

*1653. The Ireland Disaster (Editorial comments on the subject, proving the inefficacy of law to procure safe buildings). Br Build–Sept. 1200 w.

*1654. The Brick Architecture of Holland. Ill. R. Clipston Sturgis (A brief history of the people who have made so great a mark in the history of nations, with a consideration of their architecture). Br Build–Sept. 2500 w.

*1666. Housing of the Working Classes in Berlin (The condition of this class in respect of their housing appears to be about as bad as possible, calling urgently for improvement). Jour Soc of Arts–Sept. 20. 100 w.

1676. Full-Sized Foundation Tests in Calcutta. Ill. Hugh Leonard (Abstract of a paper in Jour. of Roy Inst. of Brit. Arch. These tests were instituted to ascertain what weight could be put on the usual foundation soil without causing perceptible sinking. The soil is soft alluvial. It was found to sustain 1 ton per sq. ft. without any sensible settling). Eng Rec–Sept. 28. 1100 w.

*1706. What Should Be the Type of a Modern Cathedral? (Editorial consideration of the subject as to plan and style). Builder–Sept. 21. 2500 w.

*1707. The Influence of Poetry on Architectural Development. G. L. Sutcliffe (From an Essay in competition for the medal of the Inst. of Architects, which obtained the second place and a prize. The poet's business not to catalogue the beauties of a building, but to convey the emotions which the building excites). Builder–Sept. 21. 3600 w.

1754.—$1.50. The Philadelphia and Reading Terminal Railroad and and Station in Philadelphia. Joseph M. Wilson, with Discussion (Purpose for which the railroad was constructed, and a detailed, illustrated description of the terminal station with general plans. Interesting engineering and architectural features are comprised in the design. The specifications for different kinds of work are also given). Trans Am Soc of Civ Eng–Aug. 21700 w.

1798. Heavy Framing in Wood and Iron. Ill. F. E. Kidder (In a series of articles under this heading the writer proposes to describe the most approved methods of framing floors, partitions, trusses, etc., where the construction is a combination of wood and iron or steel). Arch & Build–Oct. 5. Serial. 1st part. 1800 w.

1799. Some of Scotland's Ruined Abbeys. Ill. Howard Crosby Butler (Descriptive. The influence of David I. upon Architecture in Scotland). Arch & Build–Oct. 5. 2000 w.

1838. Art in the Modern Church. Barr Ferree (An attempt will be made to examine the present position of church architecture in America from the standpoint of Christian art. The artistic and religious standard of the American church considered extremely low). Am Arch–Oct. 5. Serial. 1st number. 5000 w.

1839. Small Churches in the Isle of Wight. A. B. Bibb (Descriptions of small churches offering many points of interest to students of architecture). Am Arch–Oct. 5. 2000 w.

We supply copies of these articles. See introductory.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

A Ship Canal from Lake Erie to the Hudson.

UNDER the above caption *The New York Times* (Aug. 29) opens the discussion of the most important canal scheme of the day. It begins as follows: "Under the authority of Chapter 79 of the laws of 1895 the people of this State (New York) will vote on the proposition to issue bonds of the State to the amount of $9,000,000, the proceeds to be employed in improving and deepening the Erie, the Oswego, and the Champlain canals. Should the issue of bonds be authorized by a majority vote of the State, the Erie and Oswego canals, under the terms of the act, will be deepened to 9 ft., their present depth being 7, and the Champlain canal will be deepened to the uniform depth of 7 ft. The locks of the canals will also be lengthened, and vertical walls constructed wherever they may be required." The *Times* discusses and strongly criticises the above project as being insufficient for the commercial demands of the country, and advocates a ship canal which shall be 26 ft. deep and 125 ft. wide at the bottom. This would float the largest lake vessels, and such a capacity is necessary, for it is rightfully argued that the present 3000-ton lake steamers will soon give place to those of greater capacity. Small-capacity boats are not economical; the owner of the 250 ton canal boat is lucky if he pays the season's expenses. Such a canal, following the Erie canal and the Mohawk to the Hudson, could be built for less than $200,000,000. "Another proposition that has been considerably discussed is the construction of a canal around the Niagara Falls, giving the lake vessels a deep waterway to Lake Ontario, whence they would reach the Hudson through a canal constructed from Oswego to Syracuse, thence to Utica, and along the Mohawk to Troy." The cost of a canal around Niagara Falls is estimated at $23,000,000, that of one along the Mohawk at $60,000,000, and the work of connecting the Hudson with Lake Ontario would bring the total to $100,000,000. About 30 miles of the Hudson would have to be deepened, bringing the grand total nearly to $150,000,000. Speaking of the increase of traffic that would result, the *Times* says: "Its magnitude may be inferred from the figures showing the tremendous volume of lake commerce. The extent of the lake trade is millions of tons greater than the combined entrances and clearances of all the seaports of the country,—even greater than those of Liverpool and London. The traffic of the Sault Ste. Marie canal is 50 per cent. greater than that of the Suez Canal." Referring to the immense resources of the west, it says: "To connect this affluent region by a deep waterway with the great port of the country, where 70 per cent. of the foreign imports are entered and from which 40 per cent. of the country's exports depart, is a work which even a less aggressive and enterprising people than the Americans would in time attempt, even if the difficulties were vastly greater than those actually existing. . . . . Canada's expenditure for canals which directly threaten our trade has already exceeded $75,000,000. We spent about $7,000,000 in building the Erie canal, and now propose to enlarge it to the next highest stage of inefficiency with the beggarly sum of $9,000,000. The Canadians are by no means visionary in their canal policy. The distance from Duluth to Liverpool by way of Erie canal and New York is 4557 miles; by way of Montreal and the St. Lawrence, 4144 miles; from Duluth to Montreal the distance is 1354 miles; and from Duluth to New York it is 1517 miles." The saving in time will be considerable, as vessels travel in ship canals at a speed twice as great as that of our present canal boats drawn by mules.

This canal would be of importance in another particular. The Canadian canals will open the lakes to foreign invasion in

times of war, and, unless the gunboats of the Atlantic could be utilized, great damage would be done and troops landed before defence were possible. "It must not be forgotten that Chicago is building a drainage canal of 21 ft. in depth to the Mississippi. With a ship canal from the Hudson to Lake Erie, it would be possible, therefore, for light-draught gunboats to make the complete internal circuit from New York to New Orleans. . . . There is something to stir the imagination in the grandeur of an undertaking which would extend the facilities of deep-sea transportation 1500 miles inland to the heart of the richest continent in the world. . . . . It is full of the courageous spirit of the modern man." There is everything to be said in favor of the ship canal proposed. It is a question of national importance, in which our government should bear its share of the expense.

The Specific Gravity of Cement.

IN the report of the *Commission des Méthodes d'Essai des Materiaux de Construction* the distinction between weight per barrel and the specific gravity is clearly drawn. A good Portland cement must be well baked to a dense clinker before being ground, in order to insure the chemical union of the mixture into a compound whose composition corresponds to the theoretical formula used. If this is not done, some of the lime may remain uncombined, and thus injure seriously the time-resisting qualities of the cement. Density thus being a desirable feature, the heavier brands sold best until it was ascertained that the finely-ground cement weighed relatively less. *The Engineer* (Sept. 13) thus comments upon the above report: "Consumers were quick to recognize that a finely-ground cement necessarily weighed less—other things being equal—than one which was coarsely ground, and, moreover, that it was not easy to make a satisfactory sliding scale and form a standard of relation between fineness and weight per bushel. At this juncture appreciation of the fact that the specific gravity of a cement is unaffected by the degree of fineness led to the general abandonment of the use of weight per bushel, and to the adoption of the determination of specific gravity in its place. The upshot at the present time is that the specific gravity of a cement is generally conceded to give all the information concerning the quality of a cement which was afforded by the former methods of testing, and, in addition, to give certain other indications of its own. When properly carried out, the experimental error is much smaller, and the results obtained require fewer corrections in order to afford a consistent meaning." Opinions thus decid-

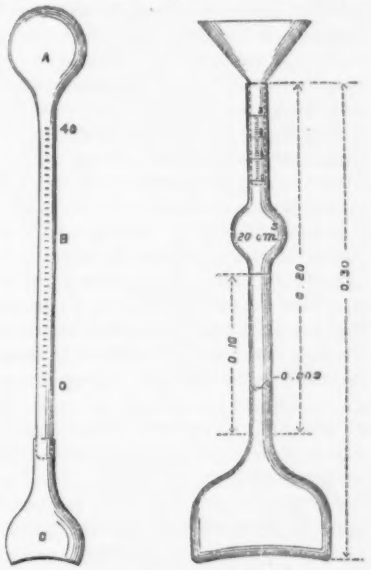


FIG. 1 FIG. 2

SPECIFIC GRAVITY OF CEMENT.

edly expressed by *The Engineer* certainly carry considerable weight, and suggest at once the performing of parallel trials with such tests as tension, compression, absorption, setting, boiling, etc.,—those generally adopted. It would be a splendid thesis subject. Water cannot be used in these determinations, and various oils are suggested; benzine seems to be preferred.

"Blast furnace slag has a specific gravity of 2.60, and the admixture of any serious proportion with a true Portland cement will be at once indicated by a low specific gravity of the product. . . .

A well-burned cement was found to have a specific gravity of 3.154, and one which was underburned gave the figure 3.108. As gravity can be determined accurately to 0.005, therefore there is no difficulty in telling a well-burned from an imperfectly-burned cement by this method."

The illustrations show two of the best forms of gravity apparatus used; both are made of glass.

The apparatus of M. Caudlot (Fig. 1.) has the bulb A filled with benzine, and is then inverted over the closely-fitting flask C; a reading on the graduated tube is taken, a known weight of cement inserted into C, and the tube again read, the difference in readings representing the volume displaced. The apparatus officially adopted by the commission, however, was that of M. H. Le Chatelier (Fig. 2). This flask has a capacity of 120 cu. cm., with a neck 20 cm. long and a bulb 20 cu. cm. in capacity, the graduations above which for a volume of 3 cu. cm. having a scale with 0.1 cu. cm. divisions, and a diameter of 9 mm. The flask is filled with benzine to the mark below the bulb, and 64 grams of the cement are gradually introduced through the funnel, until the benzine reaches zero on the scale, representing 20 c.c. of cement; its weight is determined by weighing what remains and subtracting from the original quantity of 64 grams. Or the total quantity may be inserted, and the volume read on the scale. Air bubbles seem to be the principal difficulty to be overcome. The method is rapid and easily performed, and could be readily adapted to any laboratory.

Interstitial Space.

UNDER the above caption the space between small particles is discussed in relation to the mixing of concrete by Mr. T. Dunkin Paret (referring to an abstract of a paper by M. S. R. Newberry) in the *Journal of The Franklin Institute*. In an abstract of this article *The Engineering Record* (Sept. 14) states that "it is well known that the voids in a mass of particles all of nearly uniform size are greater than when the dimensions of the particles vary largely, and hence in cement testing the voids in standard sand, carefully ground to be as uniform as possible, are much greater than in ordinary gravel." The abstract then states that, "in making a concrete, the materials should be mixed so as to fill the voids as full as possible, the amount of cement required for this being increased by 10 to 15 per cent. for safety." To show that a suitable addition of gravel will strengthen the concrete, the writer gives a table of proportions of cement, gravel, and sand, with the crushing strength of each. Mr. Paret states: "If an absolute rule could be discovered by which proper proportions could in all cases be arrived at, such a rule ought to be of inestimable value, not alone in its relation to the manufacture of concrete, but also to the proportioning of very many mixtures." In some investigations to determine the cause for the variation in quality of emery wheels, a series of experiments was performed which brought out some facts regarding the air spaces between the grains of emery. The following table will show how, as the fineness increases, the weight per cubic inch decreases and the interstitial space increases,—*i. e.*, the finer the material, the greater the volume of air spaces:

Name of Emery.	Number of Emery. Meshes per Inch.	Minims of Water Required to Fill Interstices in 1 Cubic Inch Emery.	Weight of 1 Cubic Inch of Emery in Grains	Per Cent. of Water by Weight Required to Fill Interstices in 1 Cubic Inch Emery.
Tanite Mills Emery	6 U C	131	845	14.05
" " "	10	133	842	14.30
" " "	14	137	839	14.75
" " "	18	139	833	14.99
" " "	24	140	830	15.20
" " "	36	140	826	15.32
" " "	54	141	822	15.51
" " "	80	147	812	16.07
" " "	100	153	812	16.88
" " "	140	160	804	17.80
" " "	180	164	802	18.17
" " "	200	164	802	18.17
" " "	Ex R.F.	180	427	22.27
Average		148	816	16 32
Equal parts by weight of the above 13 sizes		96	675	8.73

These tests were made each in the same manner. It would appear that an analogous process might be used in the investigation of concretes. "While the crushing

strength of concrete is no doubt largely affected by the cleanness, roughness, and augularity of the freshly-crushed stone surfaces, and by the areas of the lime and silica which comes in contact, it nevertheless seems evident that the crushing strength would be greatly modified by the amount of filling between the stone being so carefully proportioned to the interstitial space that, when that coarse stone was compressed to its utmost extent, the irregular space would be completely filled, while the faces of the stone which came nearest in contact had only a slight layer or filling between them." As showing the space between large particles, the following table will be interesting:

Name of Material.	Approximate Size in Inches.	Weight of 1 Cubic Foot of Material.	Water Required to Fill Interstices Contained in 1 Cubic Ft. of Material, Pds.	Per Cent of Water by Weight Required to Fill Interstices Contained in 1 Cubic Foot of Material.
Broken ore (emery)	3½×3½×2¼	126	25⅛	18.83
" " "	3½×2¼×1¼	116	3⅛	21.75
" " "	2 ×1½× ¾	121¾	31	20.36
Rounded stone from creek.....	2¼×1½×2¾	95	27	22.13

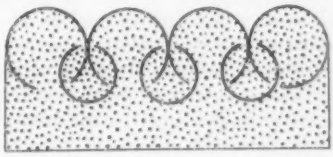
"On theory, it might have been imagined that the rounded stone would, as has been suggested for exact spheres, contain more interstitial space than the crushed ore, but the crushed material was so irregular that it formed bridges, and, unlike the fine emery grain, and unlike the stone pounded down in cement and sand, it could not bed itself or become more compact, but remained in the loose position in which it was thrown.

"The facts here given are not presented as affording an adequate explanation of how a perfect cement can be made, but are rather intended to suggest to other investigators practically interested in the subject a method by which exact results can easily and cheaply be secured."

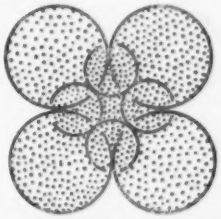
Tubular Structures.

IN these days of cheap construction any new device for economy in manufacture or installation is welcome. A novelty comes to us from London through the *Iron and Steel Trades Journal* (Sept. 7), valuable on account of its great degree of adaptability. It consists of a split tube of iron or steel of various thicknesses, engaging at their ends by threads or inter-locking devices. Reference to the accompanying cuts will show the method of fastening together laterally by other split tubes.

"If thick metal be used, it is clear that a very firm grip can be secured, if the width of the slit between the converging edges is rightly proportioned so as to be rather less than the united thickness of the two tubes which it grips. If thin metal be used and stiffness for compressive strength is required, a filling of concrete is inserted which keys the ironwork together. . . . Any number of exterior tubes, from three or more, can be employed in making a column or post, and any thickness of metal, from the thinnest upward."



The material can be used in all varieties of architectural and engineering structures, such as bridge piers, warehouse floors, portable houses, lamp-posts, etc. A series of tests, by Messrs. Kirkaldy & Son, on columns made of tubes of 24 b. w. g. thickness with concrete filling, showed the value of even this thin metal, as "these columns bent to a very marked degree without showing any opening between the various tubular members, showing the strength of this system of jointing. Pieces of wall tested, formed of 2-in. tubes 24 gage, inter-

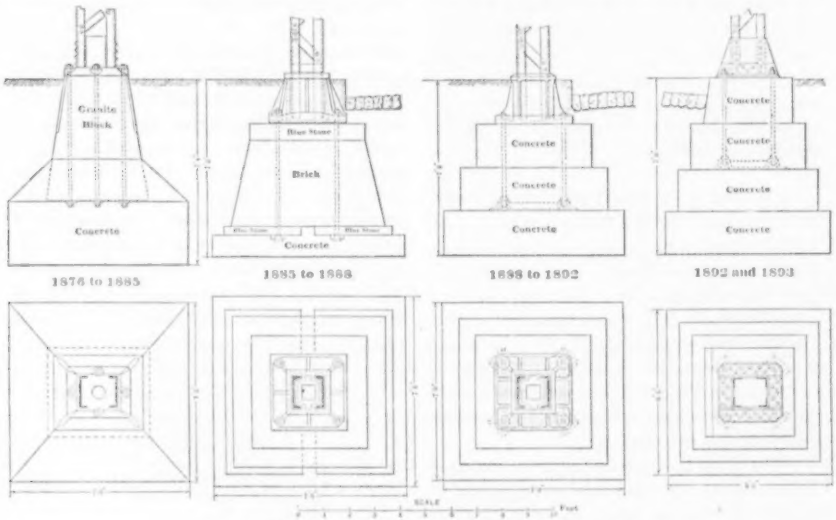


locking so as to form a wall 3 in. thick and 8 ft. high, carried an ultimate load of 17½ tons per running foot."

For walls or partitions these tubes may be left empty or filled. The chief recommendation, however, is low cost. "Owing to the fact that the bending of the material is a rapid and cheap operation, and also the threading together of the same, it is expected that before long columns and posts of this description will be employed for almost every purpose, from the largest bridge pier to the smallest lamp-post."

Elevated Railroad Column Foundations.

THE theme of a paper recently read before the Engineers' Club of St. Louis upon the Brooklyn Elevated Railway, by Mr. A. A. Stuart, was the development toward cheaper and simpler structural design. The author finds this tendency in the elimination of unnecessary braces and stiffeners from the girders and column fasteners, and still more plainly in the construction of column foundations. The cuts of foundations at different dates, here reproduced from *The Engineering Record* (Sept. 14), explain themselves.



DEVELOPMENT OF AN ELEVATED RAILWAY STRUCTURE.

"There is nothing unusual or novel in the present type, except perhaps the fact that the concrete is brought to the surface and the columns rest directly upon it, and the subsequent treatment of the exposed surfaces. After the erection of the ironwork, the top surface of each foundation, and its faces for a depth of about 6 in., were roughly pointed off, and then finished with about 1 in. in thickness of a fine concrete, locally called 'Kosmocrete,' composed of the best imported Portland cement and finely-crushed granite,—a composition similar to that used in sidewalks in St. Louis. This work is very much cheaper than the capstones generally used for such purpose, costing but $5 per foundation, by contract, and it was tested before its adoption. Thus far its use has been eminently successful."

The Resistance of Rivets.

IN a special inquiry into the causes for the deterioration of metallic structures, M. Depuy, at the direction of the minister of public works (France), has begun with an investigation on rivets, resulting in the following conclusions.

"(1.) Rivets and bars submitted to tensional stress exceeding the original limit of elasticity; the outside fibres appear to be more strained than those near

the center of the rivet. (2.) The rivets do not exactly fill the holes, but they clamp the plates together with a pressure that gives rise to a resistance to sliding equivalent to a weld. (3.) The resistance of the plates to sliding is greater as the limit of elasticity of the material of the rivets is higher. (4.) The limit of resistance to sliding is very variable, the causes being numerous and depending on the nature of the material of the rivets, on the temperature at which the riveting is commenced and finished, and on the method of riveting employed. (5.) The resistances to sliding that may in practice be reckoned on with a joint consisting of not less than three rivets are the following:

Limit of Elasticity of Metal forming the Rivet per Square inch.	Method of Riveting.	Temperature at which the Rivet is Closed.	Resistance per Sq. in. of Sections of Rivet to be Sheared.
Metric tons.			Metric tons.
11.4 (iron)	Hand	Bright red heat	2.5
14.0 "	"	" " "	3.0
11.4 "	Hydr'lic	White heat	3.2
14.0 "	"	" "	3.7
14.0 (steel)	Hand	Bright red heat	2.85
14.6 "	"	" " "	3.2
14.0 "	Hydr'lic	White heat	3.8
14.6 "	"	" "	4.2

The hydraulic press used gave a pressure of 38 tons per square inch of rivet section. In all cases the pressure was maintained till the rivet had cooled to blackness. The riveting cups left no mark on the plates. The material was such as to give an extension of 12 per cent. for iron and 18 per cent. for steel before fracture. (6.) When there are several rivets to a joint, they all yield at once. (7.) If yielding has occurred at a joint with deformation of the rivets, the deformation is permanent; but apparently no new effort which does not exceed that which caused the partial failure gives rise to further deformation. (8.) The effort necessary to shear rivets, per square inch of the sections to be sheared, is not less than three-fourths of the tensile strength of the rivet per square inch."

Of the conclusions arrived at which are not usually touched upon, the few rules below will be interesting.

"(1.) The coefficients of safety relating to the rivets depend in no way upon that of the bars. (2.) In bridge work, cross girders should not be over 13 ft. apart to secure safety for the rivets. (3.) Secondary stresses, if not allowed for, may cause the rivets to yield, which will shorten its life, though not necessarily imperil the structure."

These investigations are published in full in the *Annales des Ponts et Chaussées* (Jan.), and should be read by all bridge engineers.

THE Chicago Subway Arcade and Traction Co. is seeking the permission of the city to build 14 miles of subways. "The plan" says *The Engineering News* (Oct. 10), "is to excavate 16 feet below the street surface from house to house, and to cover over this space with an iron and concrete roof, supported on steel columns. All street railway traffic would then be operated in the subway, leaving the street proper for ordinary traffic. Sidewalks and stores will face the subway and all will be well ventilated and brilliantly lighted."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Bridges.

*1301. Will a Bridge Across the Hudson River Pay? Ill. Gustav Lindenthal (An analytical estimate for the first year's revenue of the proposed North river bridge, and of the probable increase of revenue during the first decade, —reached by comparison with the Brooklyn bridge and the New York elevated railroads). Eng Mag-Nov. 3500 w.

1336. The Konigin-Carola Bridge, Dresden. Ill. (A description of a bridge over the Elbe just completed. It is of beautiful design and adds to the attractiveness of this much admired city). Sci Am Sup-Sept. 14. 500 w.

1354. A Diagram for Determining Economical Depth of Girders (Diagram with curves showing the relation between depth of beams, stringers, etc., to the maximum bending moments, with development of formu'æ). Eng News-Sept. 12. 500 w.

1360. Transporting a Plate Girder 123-ft.

We supply copies of these articles. See introductory.

Long. Ill. (Views and detail drawings). Eng News-Sept. 12. 700 w.

1366. Longitudinal Bracing for Timber Trestles. M. E. Yeatman, in Jour. Asso. of Eng. Soc. (An improvement suggested). R R Gaz-Sept. 13. 800 w.

*1450. The Bellefontaine Bridge (Description in detail of iron bridge over the Missouri, 8½ miles above the Mississippi, with drawings and copies of specifications). Engng-Sept. 6. Serial. 1st part. 1900 w.

1461. True Economy in the Design of Bridges. J. A. L. Waddell (A technical article which is to constitute Chapter III. of a book now in preparation by the author). Eng News-Sept. 19 2000 w.

*1481. Suspension Bridges of Maximum Span (Editorial abridgment of report of the U. S. Corps of Engineers appointed to investigate this subject). Eng. Lond-Sept. 13. 3000 w.

*1587. On the Resistance of Rivets. — Dupuy (A condensed summary of rules and principles). Ir & St Tr Jour-Sept. 14. 1000 w.

*1614. Solid Floors for Railroad Bridges. Their Merits and the Calculation of Their Stresses (Description of various plans with calculations of strength. Discussion and cuts). Jour Asso Eng Soc-Aug. 5800 w.

1782. Sixteenth Street Lift Bridge, Milwaukee (Description of a double-rolling lift bridge across the Chicago River, 88 ft. long, center to center. Fully illustrated by details and views). R R Gaz-Oct. 4. 1000 w.

1792. A Melan Concrete Arch in Eden Park, Cincinnati, O. Ill. Fr. von Emperger (The arch of this bridge is stiffened and bound by I beams, running along its length, inside the concrete). Eng News-Oct. 3. 1300 w.

*1804. Cylindrical Bridge Piers: New Zealand Midland Railway. Henry William Young and Walter Cleeve Edwards (Description of method of construction with plans and numerous cuts). Ind & Ir-Sept. 27. 3300 w.

†1823. Working Stress in Girder Bridges. F. J. E. S. (Indian Government rules for apportioning sizes of various parts of bridges and girders for dead and live loads. A criticism). Ind Engng-Sept. 7. 2900 w.

1849. The Bellefontaine Bridge. Ill. (Two views with detail drawings of a four span—each 440 ft.—trussed railroad bridge over the Missouri River near Alton). Ry Rev-Oct. 5. 1200 w.

1857. European Prize Designs for Bridges. J. Kübler (Specifications and designs of four European bridges, two over the Danube, one over the Po, and one over the Rhine, with description and drawing of each). Eng Rec-Oct. 5. 3300 w.

1858. Suspension Bridges. Leffert L. Buck (A lecture before the students of the Rensselaer Polytechnic Institute containing much useful information in language easily understood). Eng Rec-Oct. 5. Serial. 1st part. 7200 w.

1873—$1.50. Construction of Substructure for Lonesome Valley Viaduct, Knoxville, Cumberland Gap and Louisville Railroad. Gustave R. Luska, with Discussion (Description of a single track steel viaduct of fourteen 30-ft., and five 70-ft. deck spans; length about 800 ft., greatest height 135 ft). Am Soc of Civ Eng-Sept. 4400 w.

Canals, Rivers and Harbors.

*1384. Navigable Waterways in Great Britain and Ireland. Ill. H. B. Thwaite (Their importance and advantages to the agricultural and other interests). Commerce-Sept. 4. 4000 w.

1563. The Montreal, Ottawa and Georgian Bay Canal. Macleod Stewart (A project for connecting Lake Huron with the Lower St. Lawrence River with map of region traversed). Can Eng-Sept. Serial. 1st part. 3500 w.

1565. Concrete Superstructures—Delaware Breakwater. W. G. Warner (Description of methods employed and cuts illustrating construction of masonry and concrete breakwaters, with abstract of practice in other countries). Can Eng-Sept. 2400 w.

1593. The New United States Government Lock at Sault Ste. Marie, Mich. Ill. (Description of an 800x100 ft. ship canal lock, with map, plan, view of excavation and sketches of device for closing leak in cofferdam. An exhaustive article) Eng News-Sept. 26. 3500 w.

1595. The Brooklyn and Port Royal Dry Docks (Editorial criticism of methods and system of Navy Dept). Eng News-Sept. 26. 1000 w.

1620. The Deep Waterways Convention (Programme of meeting, list of papers received and an abstract of a paper by Mr. Clarke, estimating cost and time saved by various routes from Lake Erie to the ocean). R R Gaz-Sept. 27. 1600 w.

1623. Excavator Used on the North Sea Canal Works. Ill. (A chain and bucket excavator having a capacity of about 160 to 200 cubic yards per hour). Sci Am Sup-Sept. 28. 900 w.

1648. To Hoist Vessels from Sea Level to Lake Elevation — Another Deep Waterway Scheme. Ill. (The idea of C. N. Dutton. Extracts from Harper's Weekly. A bold scheme for a 160 ft. pneumatic lift lock brought out at the Cincinnati convention). Ry Age-Sept. 27. 900 w.

1671. The Improvement of the Erie Canal (Editorial advocating both improvement on the Erie Canal and a ship canal). Eng Rec-Sept. 28. 700 w.

*1680. Floods and Weirs (Editorial summary of two papers—one by G. J. Symons and the other by Messrs. R. C. Rapier and G. M. Stoney—presented to section G of the Brit. Asso., and of the discussion which they elicited. Mr. Symons' paper was in the nature of notes upon the Autumn floods of 1894 and the second paper treated of weirs and rivers). Engng-Sept. 20. 4800 w.

1698. The Deep Waterways Convention (Editorial comments with short abstracts from the proceedings). Ry Rev-Sept. 28. 1100 w.

1788. The Effect of the Chicago Drainage Canals on Lake Levels (Report of the Board of Engineers, U. S. A., containing the results of

original investigation tending to show that the slight lowering of the lake levels is not liable to interfere materially with lake commerce). Eng News-Oct. 3. 2800 w.

1789. Effect of the Chicago Drainage Canal on Lake Levels. L. E. Cooley (A report submitted to the U. S. Board of Engineers, containing much valuable information, but concluding that the data available was insufficient). Eng News-Oct. 3. 5500 w.

1794. Controlling the Levels of the Great Lakes (An editorial reviewing recent investigations and arriving at the conclusion that no serious results to navigation are liable to follow; but advocating government action in taking measures to control the water levels of the lakes). Eng News-Oct. 3. 2700 w.

1796. Regulating the Levels of the Great Lakes. G. Y. Wisner (Slightly condensed from a paper read at the convention of the International Deep-Waterways Asso. Effect of withdrawing water from the Great Lakes, on lake harbors, with interesting figures concerning the various lakes). Eng News-Oct. 3. 4000 w.

1797. Effect of Depth upon Artificial Waterways. Thomas C. Clarke (The relation between depth of canals and the character of vessels navigating). Eng News-Oct. 3. 400 w.

*1851. Development of Water Powers. Ill. (A few remarks on water power available, with sketch of dam and sections of three common forms of dam construction). Milling-Sept. 700 w.

Hydraulics.

1351. A New Method for Securing Foundations (Device for sinking foundations in mud by means of a solid bottom caisson pierced by down-flow pipes, carrying water down under pressure, and up-flow pipes carrying away the water with its suspended mud and sand). Eng News-Sept. 12. 400 w.

1353. Water Power Development at the Great Falls of the Potomac (A scheme for damming the Potomac by the Great Falls Power Co., for the purpose of utilizing the over-flow water for developing electricity for the electric light and railways of Washington and Baltimore. Map). Eng News-Sept. 12. 1700 w.

1358. Notes on High Masonry Dams. John D. Van Buren (Abstract of an interesting paper read before the Am. Soc. Civ. Eng., with several superimposed sections of existing dams). Eng News-Sept. 12. 600 w.

1491. The Great Dam of the Peryar, India. Ill. J. S. Chandler (Description of the turning of the Peryar River into the sterile plains of the Madura district). Sci Am Sup-Sept. 21. 900 w.

1544. Moving 36 in. Water Mains Without Shutting Off the Water. E. C. Moore (Abstract of a paper before the Amer. Soc. of Civ. Eng). Ry Rev-Sept. 21. 700 w.

1673. The Otay Dam. Ill. (The insertion of a central water-tight diaphragm in a loose rock dam 160 ft. high). Eng Rec-Sept. 28. 800 w.

Irrigation.

1490. Irrigation in India (Part of a report of the U. S. Geol. Survey, illustrated by map and sketch of bifurcation). Sci Am Sup-Sept. 21. 1900 w.

*1655. Irrigation Works Since the British Occupation of Egypt. Ill. (A complete description of damming one of the branches of the Nile to secure sufficient head for irrigating the delta). Eng, Lond-Sept 20. Serial. 1st part. 6800 w.

†1692. Irrigation; with an Example of its Application in the Arid Region of Western America. Ill. A. B. Wyckoff (Introduced by general remarks upon irrigation of arid lands. An interesting account is given of irrigation as carried out in Yakima Co., Wash. A comparison is made between the business of a farmer on irrigated land, controlling his own water supply, and the anxieties of agriculturists in humid regions, fearing constantly either drought or superabundant rain). Jour Fr Inst-Oct. 5900 w.

†1728. Future of the Arid West. Edmund G. Ross (A consideration of the advantages of irrigation, and of its hindrances. Opposed to the use of public money for the purpose. Considers how wisely undertaken irrigation can be secured at small cost, &c., &c). N Am Rev-Oct. 5500 w.

Miscellany

*1482. The Specific Gravity of Cement (Facts brought out in one of the recent reports of the French Commission on Structural Materials, with editorial comment). Eng Lond-Sept. 13. 1900 w.

1546. Portland Cement and Concrete. John Watt Sandeman (Extract from a paper read before the Inst. of Civ. Eng. Uniform system of tests of cement and important details regarding the making of cement). Ry Rev-Sept. 21. 3300 w.

1551. The Blackwall Tunnel (Brief account of work on a tunnel under the Thames. Men work under an air pressure of 34 pounds per square inch above atmospheric pressure). Ir Age-Sept. 19. 400 w.

†1739. Portland Cement: Some Points in its Testing, Uses, and Abuses. D. B. Butler (A paper read before the Soc. of Eng. on the properties which render a cement efficient. Tests to determine the same and other considerations of a practical nature). Ind & East Eng-Aug. 24. Serial. 1st part. 2000 w.

1795. The S P R Column Formula (A spirited discussion on a formula for the strength of columns by Messrs. Johnson, Pritchard, Smith and DuBois). Eng News-Oct. 3. 5400 w.

1807. Machinery Foundations. Walter H. Mungall (A comprehensive paper read before the Brit. Soc. of Mining Students, giving facts of interest). Can Min Rev-Sept. 1500 w.

1828. Subjects for Prize Papers, Institution of Civil Engineers, England (Circular issued by the Inst. containing information as to funds available for prizes. A list of subjects for prize papers, and an excerpt from the by laws, relating to disposal of papers, maps, drawings and models presented). Am Gas Lgt Jour-Oct. 7. 2500 w.

DOMESTIC ENGINEERING

Testing House Pipes and Drains.

A GOOD article on this subject, calculated to enlighten owners and occupants as well as plumbers, may be found in *Domestic Engineering* for September. These tests are named the water test, the smoke test, and the peppermint test. Presuming that the pipes are all in place and connected, but yet uncovered, and all openings closed by plugs (there are a variety of plugs for this purpose, generally constructed to become tight by expansion under pressure of a screw), the entire system is then filled with water. If the water at the highest point does not settle away after standing some time, the system is water-tight. Connections should then be completed. If the water settles, there are leaks, which should be carefully sought out and stopped. After the connections of the fixtures are made, the system should be tested again. This may be done by the smoke test, or the peppermint test, or both in succession. The peppermint test is considered by most plumbers the more delicate, but it is more difficult to apply. The smoke test is performed by generating smoke and forcing it into the pipes, while all windows, doors, or other openings which permit free circulation of air into and through the building are closed. If smoke is detected anywhere in the building, there are leaks, which may be discovered by the visible escape of smoke therefrom.

"The peppermint test is applied by taking a small bottle of oil of peppermint and a can of boiling water on the roof and pouring it down the soil pipe, immediately closing the top, and having some one in the house detect if any smell of peppermint becomes apparent, and where it comes from. This test requires delicate handling, and is troublesome. The person on the roof will have to remain some time, for, if he comes into the house, he brings the odor of peppermint with him and spoils the test."

"Maguire tabulates the following list of fifty-one specific insanitary and dangerous defects actually discovered in inspection of dwelling houses. These may prove suggestive to plumbers who are making inspections of systems of plumbing which are suspected of being defective:

"1. Common brick- or stone-built drains under basement.

"2. Large built drains, under or near dwellings.

"3. Pipe drains of larger diameter than actually necessary.

"4. Pipe drains broken, or with leaking points, saturating the subsoil with sewage.

"5. Pipe drains with built or imperfect junctions.

"6. Pipe drains under dwelling without sufficient fall.

"7. Pipe drains with fall in the wrong direction.

"8. Drains of any kind without proper intercepting traps.

"9. Drains of any kind without constant free current of air throughout.

"10. Drains without easy means of inspection.

"11. Drains carried from public sewer direct under hall door steps and under scullery floor, instead of across open area.

"12. Rat burrows from built drains, undermining floors.

"13. Rat burrows from public sewers worked along outside pipe drains into houses.

"14. Defective connection between soil pipes and drains.

"15. Soil pipes inside houses under almost any circumstances.

"16. Soil pipes inside or outside without ample ventilation.

"17. Soil pipes through pantries, larders, or stores.

"18. Defective, badly-placed, or ill-constructed water-closet apparatus and housemaids' slopsinks.

"19. Water-closet cisterns with overflows joined to soil pipes or drains.

"20. Safe trays under water-closets joined to soil pipes or drains.

"21. Two or more water-closets or sinks on one soil pipe, untrapping each other when used.

"22. Overflow pipes connected to soil pipes liable to become untrapped, all very dangerous.

"23. Water supplies over troughs taken from water-closets or other contaminated cisterns, and liable to be used by careless servants to fill bedroom carafes for drinking.

"24. Taps for supplying bedroom water fixed over housemaids' slopsinks, liable to be polluted by splash from slops emptying.

"25. House cisterns, with overflows, joined to soil pipes or drains.

"26. Traps of every kind, without ample ventilation to guard them.

"27. Scullery sinks connected direct to drains, admitting foul air, not only through traps, but through joints of brickwork and plaster all round.

"28. Bell taps, with loose covers on scullery sinks.

"29. Gullies or traps in floors of sculleries, laundries, larders, or basement, etc., connected to drain, and usually dry and untrapped, or full of foul deposit.

"30. Ventilating foul air shafts, discharging near chimneys or windows or ventilating openings.

"31. Rain pipes used as ventilators for drain discharging foul air near bedroom windows or under roof eaves.

"32. Rain pipes used as, or connected to, soil pipes, likely to freeze soil pipe solid in severe winter.

"33. Rain pipes passing down center of houses connected in any way to drains.

"34. Open rain courses from valley gutters, passing under floors to outside down pipes connected to drain.

"35. Rain pipes of low roofs, bow windows, or porches connected direct into drain.

"36. Ashpits located near larder, pantry, or dwelling.

"37. Ashpits liable to let moisture soak into house.

"38. Ashpits capable of retaining moisture, or unventilated.

"39. Rat burrows from defective drains in neighboring premises.

"40. Defective drainage or fittings in neighboring premises.

"41. Any direct communication with drains of neighboring premises.

"42. Water tanks in areas, near ashpits or sculleries, or with any connection of overflow to drain.

"43. Bath waste or overflow pipes connected to soil pipes or drains.

"44. Wash hand basin wastes or overflows connected to soil pipes or drains.

"45. Water-closet cisterns under bedroom or parlor floors.

"46. Cesspools near houses, or unventilated anywhere.

"47. Cesspools or drains near wells.

"48. Drains crossing your house from neighbor's premises.

"49. Field or surface water drains, with open joints under basement connected to house drains direct.

"50. Damp basements or damp walls.

"51. Drinking water defects of source supply or storage."

Unnatural Gardening.

AN editorial in *Garden and Forest* (Sept. 11) expresses the view that landscape art reaches its highest development when it deals successfully with the fundamental and permanent features of scenery. Ornate art is permissible in contracted spaces. In such confined surroundings flower-beds laid out by a true artist in a "strictly artificial style" are permissible. But such a style fails painfully in effect, or, rather, produces a painful sense of incongruity in any plan of grounds sufficiently large and important to be designated by the name of "landscape gardening." For example, along the Riverside drive, in New York city, there are "architectural terraces and monumental buildings which need the lines of formal planting to supplement and complete them. Along a stately promenade like the Riverside drive, where the foreground is strictly defined by a parapet, there is an opportunity within this limit for statues, and fountains, and floral em-

bellishments of the most sumptuous and elaborate kind, and this would serve as a fitting framework for the prospect across the broad river with the forest-crowned cliffs and the noble sky-line beyond. Many other places might be named where so-called decorative gardening and geometrical arrangements of flowering plants would be desirable; and, wherever a real artist gives examples of his skill in this direction, he commands the gratitude of every one interested in garden art."

While "formal gardening" is "a legitimate form of art," all formal gardening is not "to be approved." Like style in any kind of art, it has its limitations, and, the grander and more massive the subject, the broader and less formal should be the treatment. "Every one has seen geometrical flower-beds of such elaborate pattern that they never can be properly executed with plants as materials. Even where they are not intrinsically bad—that is, where the figure is pleasing and the colors are not constantly at war with each other—they are often placed where they are out of harmony with the general design and with the special features about them. Wherever in a public garden the recognized canons of art are violated, it is the province of a journal devoted to the subject to criticise such displays, and we have not hesitated to appeal to those in authority, and who are, therefore, in a substantial way, educators of the people, to furnish examples of gardening which will not offend the poorest taste. But there are worse sins than those we have named, and there is no occasion here to characterize such efforts as the portraits of eminent men on the maps of different States wrought out on the turf with houseleeks and echeverias. Such subjects, with the imitations in color of flags and banners, badges and mottoes, are too trivial for serious consideration. They discredit the very name of garden art. Wherever used, they can only disfigure our parks, and are accurately described as horticultural abominations."

Replying to a criticism of *The Independent* that all gardening is artificial, *Garden and Forest* says: "*The Independent* evidently conceives that our sole objection to it is based on the fact that 'these floral pictures are not naturalistic,' and on this assumption it argues that the same objection lies against every cultivated plant and gardening of all kinds. This statement is, in the main, true; but we have often argued that, even in the natural treatment of a landscape, there must be artificial elements which ought to be frankly used. We advocate formal gardening within proper restrictions, for the very reason that it is formal. When we protest against wall-paper designs, it is not because it is unnatural, but because they violate artistic principles in form and color and location. We need not repeat the specific exceptions we have taken against some of the displays in the Boston Public Garden and certain western city parks, but it ought to be stated that there are, in our view, serious objections to these works from economic and other points of view, aside from the fact that many of them are puerile, others are discordant in color or whimsical in form, and nearly all of them are badly placed."

That the "taste of the common people approves" these flower beds is not conclusive in their favor. The taste of the common people cannot be accepted as a criterion in any branch of art. No one would think this argument anything but absurd, if applied to painting, sculpture, architecture, or music. At the same time the taste of the common people should be considered, —rather for its permanent improvement, however, than for its immediate puerile gratification.

"Really, the bulk of our people despise shams and artifice more and more. No one now thinks of sending to a lady a heart constructed of white carnations and pierced with an arrow of crimson ones. Floral designs of fiddles and bells and pieces of furniture have given place to simpler arrangements of more harmonious color. The same change is coming in our pleasure grounds. The picture of four men of life-size rowing in a boat will not again be seen spread out in gaudy colors on the turf of any American park; and it is to be hoped that the famous American

eagle with a glass eye, and the Gates Ajar, constructed with bits of blue stone to furnish a detail when flowers of that color were not at hand, have both passed away for ever."

Superabundant Water Supply.

UNDER the title of "The Cart Before the Horse" Dr. Benjamin Lee, secretary of the State board of health of Pennsylvania (*Plumber and Decorator*, Sept. 2), calls attention to a danger arising from superabundant water supply in cases where ample drainage for removing the surplus is not available. He says: "The first thought of a citizen who proposes to build himself a country residence is beauty of location; the second, architectural adornments; the third, possibly, a copious and pure water supply, and with this modern plumbing follows, of course, as a necessary accompaniment. Last of all, he, or his architect, bethinks himself that it will be necessary to find a receptacle for his little stream which he is going to divert from its natural course and fill with the accumulated filth of his household. That which should have been most carefully considered first, before a line was drawn or a plan designed, is left to be provided for last in some haphazard way, as if it were a trifling detail of no moment whatever. The problem may prove impossible of satisfactory solution to himself. Or, if provision can be made in such a way as to relieve himself of annoyance, the chances are ten to one that his neighbor will begin to complain of the flooding of his yard or the pollution of his well; or, what is still worse, and unfortunately of frequent occurrence, sickness may be created in families more remote, the cause of which is unexpected and therefore unremoved.

"As an example out of many which I could cite, the following has recently occurred in my own experience. In one of the most beautiful of the suburbs of Philadelphia resided a gentleman whose business took him to the city every day. The situation of his house was delightful, the drainage of the neighborhood good, the water pure. Every prospect pleased, and only man was vile. Next to his place, and on higher ground, was a comfortable family mansion on a comparatively small plot of ground. The owner of this mansion saw an opportunity for turning it to profitable account by renting it as a summer boarding house. Its situation was attractive, and the old house was soon crowded to overflowing. It was therefore enlarged until it had a capacity for about seventy guests. The old water supply became insufficient, and a new one was introduced, affording a flow of 2000 gallons a day. And now came trouble. There was no proper provision for this flood. Trench drains were dug all over the little lot, but they were insufficient to carry it away. Flowing into the public road in front of our friend's house and even on to his property, it quickly constituted a nuisance of a very serious character. The State board of health was appealed to, and, as the neighborhood, though quite populous, was without incorporated rights or local health authorities, considered it to be its duty to interfere. The effluent was carried under the surface to an old sewer at a distance, and the trouble was temporarily remedied, although by no means satisfactorily and permanently. But now comes a curious part of the story. The engineer inspector did not consider his full duty performed until he had also examined the drainage on the property of the complainant. This gentleman had prided himself on the perfection of his 'sanitary' arrangements, and yet all of his drainage was received into a leaching cesspool, which was close to the house and evidently constituted a serious menace to the health of his own family."

The article concludes with a caution against a too copious water-supply, which may become a means of distributing pollution, and an admonition to architects and owners not to consider the subject of supply before that of drainage, which is what the author calls putting "the cart before the horse."

THE German Hygienic Association offers a prize of $1,200 for a research essay on the efficiency of electric heaters. The programme is as follows: "The heat given out in heating installations by heaters in

their various forms and modes of use is to be ascertained. The investigations are to describe in detail the arrangement of the heaters, the nature of the heating agents and the observations made, and to be illustrated by drawings. The heating values are to be stated in units of heat given off per hour per unit of surface. In case of heat given out to air, investigations must be conducted with currents of air at speeds as different as possible. Heaters are to be described in detail, and the relation of heating efficiency to their weight to be ascertained." Essays are to be written in German, and sent with a motto and sealed envelope to Prof. Konrad Hartmann, Charlottenburg, Fasannstrasse, 18, before July 1, 1896.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Domestic Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Heating and Ventilation.

1467. Heating of Forcing-Houses. L. H. Bailey and E. G. Lodeman (From Bulletin 96 of the horticultural division of the Cornell University experiment station, Ithaca, N. Y. An account of experiments in practical heating of forcing-houses). Heating & Ven-Sept. 15. 2000 w.

1468. Boiler Rating. J. G. Dudley (An attempt to classify and bring heating surfaces of different types and sources of heat, each to a common standard, as a basis for estimating evaporative capacity). Heat & Ven-Sept. 15. 1800 w.

1610. Heating and Ventilating in Office Buildings. Ill. (Plans, specifications and full description of heating and ventilating appliances in the 16 story Marquette Building, Chicago). Mas. St Fit-Sept. 700 w.

*1663. The Heating of Buildings—Are the Americans Ahead? (American and English practice compared). Irm-Sept. 21. 1400 w.

1677. The House of Relief. Heating and Ventilation of a New York Hospital. Ill. (Full description with plans). Eng Rec-Sept. 28. 2200 w.

1859. Hot Water Heating and Ventilating in a Large Church. Ill. (This example of hot water heating, described with plans, etc., is notable for the size of the auditorium heated and ventilated, the cubic space therein being 1,060,000 cu. ft.) Eng Rec-Oct. 5. 1200 w.

Landscape Gardening.

1313. Unnatural Gardening (Editorial discussion of the subject, pointing out some of the details that offend pure taste). Gar & For-Sept. 11. 1700 w.

1320. The Palisades Mountain Park. Ill. C. (A general statement of the fundamental conditions of the problem which the Commissioners have to solve.) Forester-Sept. 1. 1800 w.

1555. A Great Battle Park (Editorial on the dedication of the battlefield of Chickamauga). Gar & For-Sept. 18. 1000 w.

1571. Landscape Art in the Military Parks (Editorial in defense of artistic treatment of such parks). Gar & For-Sept. 25. 1200 w.

1734. Suggestion for Autumn Gardens (Editorial calling attention to the harmony that may be produced by attention to color, and selection of plants). Gar & For-Oct. 2. 1200 w.

1735. Late-blooming Hardy Herbaceous Plants. J. Woodward Manning (List of hardy plants for autumn blooming). Gar & For-Oct. 2. 1600 w.

Plumbing and Gas Fitting.

*1431. Testing House Pipes and Drains (An enumeration of fifty-one places wherein danger may lurk). Dom Engng-Sept. 800 w.

*1432. Four Varieties of Lead Pipe Joints. Ill. (A practical discussion). Dom Engng-Sept. 900 w.

*1433. Forty Thousand Dollar Job of Plumbing (Specifications of plumbing fixtures in American Tract Society's Building, New York). Dom Engng-Sept. 1600 w.

1552. Rain Baths. Ill. (Discusses the advantages of the so-called "rain bath" and gives a description of a bath room in Utica, N. Y. hospital fitted with douches supplied by the Gegenstrom apparatus, from designs by Paul Gerhard, Sanitary Engineer). San Plumb-Sept. 15. 1700 w.

Miscellany.

*1347. The Cart before the Horse. Benjamin Lee (Discusses the desirability of copious water supply, but points out that in rural districts a want of proper drainage may render a copious supply dangerous to health). Plumb & Dec-Sept. 2. 1300 w.

†1375. Sewage Disposal for Country Houses. Ill. William S. MacHarg (Illustrates the evils of all methods of storage of solids and of constant discharge of liquids upon the surface of the ground; also considers the "Intermittent Sub-Surface Irrigation" system and its advantages). In Arch-Sept. 1400 w.

1556. Protection from Lightning. Ill. (Abstracts from a pamphlet by Alexander McAdie). Arch & Build-Sept. 21. 3700 w.

1630. Incrusted Deposit (Discusses the fouling and cleaning of water-backs in domestic ranges. A good practical article). F. Dye in London *Ironmonger*. Met Work-Sept. 28. 2000 w.

We supply copies of these articles. See introductory.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading and Domestic Engineering.

Better Construction Work Wanted.

MR. KEPPELE HALL (*Electrical World*, Sept. 17) comments upon the alleged fact that experimental work and theoretical discussions are occupying space in electrical journals to an extent that leaves "little time or space to be devoted to the practical side of electrical engineering." It is true, as Mr. Hall alleges, that electrical construction "is not in its infancy." It has grown to adult stature in a marvelously short period, and perhaps this very fact not only accounts for, but justifies, the course of electrical journals in paying greater attention to explorations in new fields than to topics familiar to electrical engineers and constructors. For these journals are published for and circulate among a technical and professional constituency. Except through the medium of reprints and reviews, they scarcely reach lay readers at all. It may be and probably is true, as Mr. Hall declares, that "the average electric installation is inexcusably poor, displaying for the most part poor workmanship, poor arrangement, and poor judgment." But, when he says people do not tolerate poor work of other kinds, such as carpentry, mason-work, and plumbing, we think he is going farther than facts will warrant. Our observation leads to the belief that the average job of carpentry, mason-work, plumbing, or heating work might justly be called inexcusably poor, also. But the average job of electrical construction is not generally found alongside the average job in other departments of building and house-fitting, except in city flats; and, if the average carpentry, masonry, and plumbing in buildings wherein electricity is used for illumination are alone meant, we will not quarrel with the statement. The fact remains that there are many incompetent men who are engaged in electrical construction. As Mr. Hall says, "new electrical light and power companies are being incorporated, more people are availing themselves of the advantages offered, and more men are offered to do the work. A large majority of those who turn to this field are incompetent, and a large proportion of the gullible public are yet to be gulled before they learn by sad experience their error. Now, all this will take time, and in the meanwhile the reputation of the profession must suffer in consequence, unless some urgent measures are taken by those who are really first-class to protect themselves. This requires the coöperation of the public and the good contractors.

"When a man wants work done, and gives it out to contractors to bid on, and receives a number of proposals, all in conformity to the general specifications, but varying widely in price, he almost invariably selects the lowest bidder, especially when he does not know much about it himself, and cannot understand why there should be such a discrepancy in the price when all are going to do about the same work." All this is as true for any other kind of competitive contract work as for electrical work. He who expects uniformly good work done by contract in open competition with other contractors will be surely disappointed. The case is different when only high-class contractors are invited to bid. The competition, thus restricted, may result in good work; but the temptations to overstep a wise limit in competition are great, and even good contractors are often placed, by the acceptance of their bids, in a position where they must either lose money or do inferior work. Experience has proved that human nature is weak in such cases.

The article gives many useful hints and cautions to those that need them. Carpenters make the best wiremen. "They know how a building is put together, they know where they can cut joists and stringers, and—what is just as important, if not more so—they know where they must not cut and notch. They know how

to remove and replace lath and plaster, when this is necessary, without tearing down the whole wall of a house, and appreciate the necessity of having good sharp tools to work with.

"Cheap sockets, switches, cut-outs, wire, and other materials may last for a time and give satisfaction temporarily, but eventually they will get out of order and give trouble."

"Concealed work done in anything but conduits" is condemned. "Contractors may insist that wiring in porcelain tubes and cleats, under the floors and behind the plaster, is plenty good enough, and that there will be no danger of anything going wrong. This is not so. The insurance men may permit the practice, but fire is not the only thing to be guarded against. Plumbing or carpenter work will be done some time, and a wire will be broken or grounded, and then comes the search for the trouble, with the consequent tearing up of floors and walls before the trouble can be reached and remedied." A conduit obviates all these contingencies. "Group cut-outs and fuse-blocks separately, as far as is possible in small buildings; and, where this is impracticable, as in a very large building," select distribution centers for each floor, and gather the cut-outs there, each fuse having "a stamped copper terminal showing the carrying capacity," so that, "when a fuse blows, one knows what to replace it with."

"Great care should be taken not to have any one set of lights on one fuse, but all should be arranged so that, when one circuit is disabled, no place will be left in total darkness. Then there are the miserable switches that are so flimsy that they melt up when half loaded, or are so poorly adjusted that they can't be depended upon for half a day at a time. The same may be said of sockets and other materials. This is what makes the cost of house wiring vary so in amount, and it is not simply necessary to look at a man's bid before giving him the work, but to examine his materials and see what he is going to use and how he is going to use them."

"A contractor can generally be sized up from the way in which he performs small jobs. Every man in the construction business is called upon, from time to time, to do small pieces of work, not amounting to much in cost or profit, but work that must be cheerfully done and well done, in the hope of some time securing larger work from the same party. Let us take, for example, ordinary bell wiring for call bells or annunciator. Bell wires should never be run in plaster under one staple. Installations put in in this miserable manner may give satisfaction for a long time, but, when once trouble does occur, it is next to impossible to remedy it. Bell wires, where they run behind plaster, should always be run in tubing, and the man who takes this precaution and uses bells that can be relied on not to get out of adjustment for years, push buttons that will continue to work satisfactorily after long usage, and good reliable batteries, is the man to be trusted with large contracts, with the assurance that the work will be done with the same painstaking care that has characterized his other work."

In conclusion, contractors are advised never "to do inferior work in order to secure a contract. This principle adhered to will eventually lead to success." The author confesses that in all this there is nothing that is new to the profession, but it may serve to guide non-professsional men into wiser courses in contracting for electrical work, and enable them to form a better judgment upon the character of its performance.

Municipal Electricity.

THE above is the title of a paper read by Mr. James Perry before an association of municipal and county engineers at Londonderry, and printed in *The Electrical Engineer* (London, Aug. 23). Mr. Perry is part owner and engineer of the company whose purpose is the public and private supply of electricity in Galway," and he prepared this paper because he "thought that his views and experience . . . . have some interest to his brother municipal engineers." There is a vein of common sense in what Mr. Perry says, but his disparagement of theoretical knowledge does not commend him as an instructor.

Commenting upon this paper editorially, *The Electrical Engineer* admits that "electrical engineers may very comfortably put aside much of the hairsplitting science of the electricians without detriment to the work undertaken"; but it does not back up Mr. Perry's sweeping assertion that "the generation of electricity is purely a question of mechanical engineering." The old debate as to the relative value of theoretical knowledge and practical experience is revived in this discussion. Mr. Perry evidently thinks that a limited knowledge of theoretical principles is sufficient for the needs of the practical electrician, and, as compared with the entire theory accumulated, he is doubtless correct in the view that the principles which must be directly considered in the installation of municipal plants are really few. It would be a pity, however, that practical electricians should be led to undervalue theory. The editorial already quoted significantly says: "It would be a sad day for electrical progress if the pure electrician were to abate one jot of his energy."

Mr. Perry's paper deals mostly with the elementary knowledge needed in the installation and management of municipal plants, and emphasizes its simplicity. A quotation or two will illustrate the general tone of the paper, which, notwithstanding the common sense with which we have credited it (all the more for possessing this merit), will do harm, unless its mischievous tendency is made apparent.

"The engineer has to deal with commonplace electricity; he should in general treat it as Peter Bell did the primrose,—let his cow eat it and turn it into butter. The engineer's electricity is comparable to a leather belt or steel shafting and gearing. It is not a source of power; its humble function in the telephone, telegraph, electric motor, and electric lamp is to transmit power to a distance. Pretentious youngsters and high-falutin newspaper men may talk of the age of steam to be succeeded by the age of electricity; they might as well talk of the coming age of leather belts or of steel shafting. Why should a dairymaid, whose business it is to make good butter, bring to her butter-making the botany of the plants eaten by the cows, the physiology of the cows, and the chemical composition of the butter? It would be useful for the intelligent dairymaid to know how many ounces of butter she ought to get from a gallon of milk, the temperature at which butter comes, how much water to leave in the butter, and how she can best wash out all the remains of the milk; and she should have proper appliances to enable her to carry out the processes cleanly and properly."

It is all as simple as possible; no need for extended and exact learning. A little primer may contain the whole science of electricity so far as it is necessary for practical purposes. But a glance at only one point of the argument will suffice to show the weakness of the whole. The writer suggests a "3d rate per unit," and adds: "Other people have come to this 3d unit, and the writer is inclined to halve it, as a reasonable rate in large towns. When electricity is to be had at 1½d a unit, a 16-c. p. lamp will keep lighting during 13 hours for 1d."

This remarkable statement is justly criticised in the editorial above referred to, which, as a whole, is a complete refutation of the objectionable parts of Mr. Perry's paper.

"In our opinion, it is altogether bad to make statements of this kind. Ignorant people fasten on them, especially as the ordinary newspaper sub-editor revels in giving them a corner, and thus hundreds, if not thousands, are led to expect something altogether impossible in the majority of cases. We do not say that it is impossible here and there to produce electrical energy so that it may be sold at three-halfpence per unit, but we do say that in the majority of cases at the present time it cannot be done, and there is no likehood of its being done during the lifetime of this generation. It is the average cost and the average selling price that should be the guide, rather than the lowest possible cost and the lowest selling price under the most favorable conditions that can be obtained. It is extremely annoying for a canvasser who calls upon the house-

holder to ask him to introduce the electric light to be met with questions about the exceedingly high price which the company, or the municipality he is canvassing for, charges for the energy supplied. The canvasser is met with the statement that such-and-such an authority says the price to large towns ought to be three-half-pence per unit, and here you are charging fourpence, fivepence, sixpence, or more per unit. These charges may be low when all the conditions are taken into account, but the householder is not the person to trouble himself about the existing conditions. He merely thinks he ought to get it at a certain price, and is annoyed to think that he cannot get it at that price, and refuses to patronize the new light."

It is also alleged in this editorial comment that only a few instances could be found where the actual cost of generating electricity is less than the price suggested by Mr. Perry.

The Braking of Trolley Cars.

AMERICAN MACHINIST recently took occasion to criticise editorially an alleged inefficiency of the brakes on trolley cars, charging broadly that the subject has not received the attention in electrical journals that it merits, and substantially asserting that the alleged inefficiency indidirectly results from the fact that the armature shaft of the trolley motor is geared to the car axle.

"Any mechanic must see at once that the brake, in view of the emergency that it is supposed to provide for, is a slow-acting affair, and, if he will investigate the propelling mechanism of the car, he will easily see that it is, and why it is, purposely made so. The armature of an electric motor, as everybody knows, is quite a heavy part of it, and, running at a high velocity, it is, of course, a powerful fly-wheel; and, when it is noticed that the armature, or the shaft which carries it, is geared to the axle without the possibility of slip, the whole situation is exposed. If the axle is stopped suddenly, something is going to be smashed; so the slow-acting brake is a safety device for the motor."

Electricity (Aug. 14) calls down *American Machinist* for this criticism. It asserts truly that the subject of braking electric cars has not been neglected in the American Institute of Electrical Engineers, or in the electrical journals; it offers to prove this assertion by reference to files of such journals, and the assertion made in the above quotation it avers to be only partly true.

"The mechanical brake is a slowly-acting affair, and purposely so, but not for the reason assigned. The large angular movement of the brake handle is provided simply and solely for the purpose of mechanical advantage, and not for the protection of the gearing, as supposed. To produce the most effective braking, several requirements must be fulfilled. In the first place, the propelling force must be cut off first, and then the retarding effort must be applied. It must be remembered, too, that suddenness of application of the brake is not always or usually a requisite to a good brake."

It is added that, "were suddenness of application the sole desideratum, the electric car would have facilities not found to the same extent in other vehicles, for by simply reversing the motors the wheels would be revolved in the opposite direction. The objection to this method of procedure would not be the one raised by our contemporary,—*viz.*, that it would strip the gears (though there might be some danger of that),—but it would doubtless burn out the armature, and, even if it did not do this, it would fail to bring the car to rest as rapidly as might be done by a proper application of the brake."

The trouble appears to lie between a system which exacts too much of motormen and the motormen themselves, rather than in the brakes *per se*. *Electricity* says: "The chief difficulty with electric cars is their greater weight. No other mechanically-propelled vehicle has as good braking facilities as has the electric car if they are properly manipulated, but the motorman on the usual trolley car has too many things to attend to. He has both hands continually occupied, and, in the case of an emergency, unless he be of better stuff than the ordinary run of men, he will take

the necessary steps to check his car in the wrong sequence, or omit one of the steps altogether, both of which are equally bad.

"Electric cars, too, are run at higher speed than other street vehicles, and, although by the present means of braking, a car can be brought to rest from a speed of 10 miles an hour within a distance of 10 ft. if the braking mechanism be guided by proper intelligence, it is exceedingly doubtful if the number of accidents would be much lessened by any improved mechanism which would render stoppage possible within half the distance, unless there were a higher intelligence behind it than that usually found on our street cars."

As to the position taken by *Electricity* that increased safety in trolley railway traffic lies in the direction of improvement in fenders rather than in improved brakes, it seems, from its own showing, that improvement is needed in the system of operating the cars. The motorman performs functions in the order of which he is liable to become confused when these have to be performed in quick succession, and when he is alarmed, as he would be when in danger of running down a pedestrian. His intelligence has little to do with this state of things. Much more intelligent persons than the average motorman would become flustered and commit errors under such circumstances. An emergency drill of motormen is suggested, and might be of service, as firemen's drills have been of service; but, if the trolley lines wish to avoid the necessity of employing men of a higher grade than "the ordinary run of men," some way of avoiding the continuous occupation of both hands by the motormen seems an obvious need in trolley service.

The Tesla Patents.

THE company which controls the patents granted to Mr. Nikola Tesla evidently is planning to make it warm for infringers. In a circular recently sent out to persons and corporations deemed to need the warning, they say: "In view of the great prominence given to the multiphase motors covered by the patents of Mr. Nikola Tesla, we think it right to direct your attention to the fact that this company claims the exclusive right to manufacture and sell all forms of single-phase motors where a second phase is induced so as to make the same a two-phase induction motor, notably the form used for the operation of fans." The advice is also given to those who are using motors of the kind named to avoid permanent injunction by arranging with the company betimes, as a decision in important suits now pending is expected early in 1896, and all indications point to a decision in favor of the owners of the Tesla patents.

Progressive Age (Oct. 11), which gives these facts with editorial comments, while regarding much of the circular as "pure advertising," to be "taken with the large modicum of salt needed by the statement of a corporation with millions at stake and whose fate is still in the hands of the courts, undecided," yet feels it a duty to present the facts on the side of the company.

"It is undoubtedly true that electrical apparatus depending upon alternating currents of two or more phases will play an important part in the electrical industry of the near future. It is still more certain that a decision of the suits in question will throw a tremendous amount of existing apparatus out of legitimate use, and a corresponding amount of new business into the hands of the victor; while rumor has it that all the points of equity, if not of law, are on the side of the aggressive corporation. So that, whichever way the proceeding turns,—and we do not presume to undertake prophecy, or legal analysis of the question,—there will be a large volume of property affected, outside of that owned by the two principal combatants."

The guarantees to purchasers under which a large number of this class of motors have been sold our contemporary regards as worthless, in case the favorable decision expected by the company shall be obtained. "The intentions of the insuring party may have been of the best, but it is now clear that the liabilities which he has thus gradually accumulated are such as will fall, if at all, in a lump, and, when they fall, are certain not only to swamp,

but to leave by far the greater portion of the insured without protection or protector. The questions therefore arise: Are these parties, so plainly damaged in equity, to have no recourse in law? And if so, to whom?"

It appears to us that there is no recourse. In such cases one would wish that purchasers could be protected, if possible; but we can see no way whereby a person, having accepted an insufficient security and relied upon it as a sole remedy, can be resecured; and the editorial reviewed admits the extreme difficulty of the case. "Clearly the purchasers should be protected. But by whom? It is plainly not the duty of the successful litigant, who has been merely defending his rights. It is as plainly beyond the powers of the vanquished party. So the question is not a simple one. But it would certainly seem that, if the State cannot guarantee the validity of its patents, before it issues them, or is so slow settling that validity by other means that large numbers of its citizens become involved in losses as a consequence, it cannot be regarded as clear of blame, or at least of indebtedness."

Storage Batteries in Telegraphy.

THE application of the storage battery to telegraphic work, long since an accepted feature of the European practice, is apparently finding much favor of late in this country as well, especially as there are now but few towns of 5000 or more inhabitants in this country which are not provided with a central-station electric plant, from which the cells may be conveniently charged at any time at a trifling expense. In an article in the *Electrical Engineer* (Aug. 14) particulars of some of the most important storage-battery plants of this kind are given, illustrated with diagrams. One of these—that in Washington, D. C.,—has 724 cells; 398 of 50 ampere-hours', 320 of 12.5 ampere-hours', and 6 of 125 ampere-hours' capacity. The main battery of 640 cells is divided into 16 groups of 40 cells each, each of which is tapped so as give 4 different potentials of each polarity, for supplying telegraphic circuits of various lengths and resistances. The 6 large cells furnish 6-volt currents for 80 local sounders connected in multiple. The plant replaces 7300 gravity cells heretofore in use for doing the same work.

Monocyclic Electrical Distribution.

THE so-called "monocyclic" system of distribution,—in which the ordinary type of single-phase alternators may be economically replaced in existing stations by apparatus offering, among other advantages, that of being able to supply power to alternate current motors of a type self-starting under full load,—although much discussed in the technical journals, does not seem to be very well understood by electricians generally. In the *Electrical World* (July 27) a very intelligible explanation is given of the principles of the apparatus, which is accompanied by diagrams, and may be profitably examined.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Electricity in the American, English and British Colonial Technical Journals—See Introductory.

Lighting.

*1302. The Limits of Electric Power Transmission. Alton D. Adams (Showing, by the analytical comparison of costs, how far electric power, hypothetically costing nothing at the point of origin, can be transmitted without entailing an expense exceeding that of generating its equivalent steam power). Eng Mag–Nov. 3200 w.

*1341. Electrical Supply at 230 Volts—The 8-Candle Power Incandescent Lamp—The Electrician's Trouble (Criticism of an editorial in *The Engineer*, suggested by some experience in electric supply gathered at Bradford, Eng., and a denial of the economy of 8-c. p. lamps). Jour Gas Lgt–Sept. 3. 1300 w.

*1385. Aberdeen Electricity Works. Ill. (History and full description). Elec Eng, Lond–Sept. 6. 5300 w.

1389. The Photometry of Arc and Incandescent Lamps. W. M. Stine (An article of interest to all connected with the commercial production of illuminants or the study of their use. The measurement of arc and incandescent lights. In this number the quality and quantity of light and the standard candle power are considered). Elec Ind–Sept. Serial. 1st part. 2000 w.

We supply copies of these articles. See introductory.

1391. Electric Street Lighting. George Cutter (Abstract of paper read before the Northwestern Elec. Asso. Important points considered). Elec Ind–Sept. 900 w.

*1392. Electrical Communication between Lightship and Shore. Ill. (Descriptive of two patents having a direct bearing on the question at issue). Elec Rev, Lond–Sept. 6. 3300 w.

*1448. The Electric Lighting of the Entrance to New York Harbor. Ill. (Describes a work tending toward the more complete illumination of the entrance channel of New York harbor, just completed in accordance with the plans of the U. S. Lighthouse Board). Engng–Sept. 6. 1200 w.

*1541. The Blackening of Incandescent Lamps (Discusses Mr. G. Tolomei's experiments claimed to show that the blackening of the globes is due to something else than the deposition of carbon). Ind & Ir–Sept. 13. 800 w.

1566. The Wilkes-Barre, Pa., Electric Light Co.'s New Station. Ill. J. H. Vail (Descriptive). Elec Eng–Sept. 25. 3500 w.

1611. A Cause of Some Electric Troubles. D. Rivers (Discusses causes and remedies for troubles with small, flexible, electrical conductors, such as lamp-cords, &c). Mas St Fit–Sept. 1300 w.

1621. Storage Battery Car Lighting in Germany (Describes a system of lighting by storage batteries carried out on the passenger cars of the Dortmund-Gronau-Enschede railroad in Prussia. The accumulator cells are of the Tudor type). R R Gaz–Sept. 27. 2200 w.

*1656. The Belfast Central Electric Lighting Station. Ill. (Descriptive of one of the largest plants for electric lighting yet installed with motive power generated exclusively by gas-engines, of which there are six of 50 H. P. each, double acting with the Otto cycle). Eng, Lond–Sept. 20. 2500 w.

1710. The Incandescent Gas-Light: Its History, Character, and Operation. Ill. William Gentsch (Bids fair to be an important serial. Its form indicates that it will ultimately be re-printed as a book. It will treat of the following topics: Predecessors of the present incandescent gas-light Mantles. I. Composition. II. Form. Burners. I. Burners for gaseous fuel. Means for increasing the luminosity. II. Burners for liquid fuel. Regulation. Incineration. Protection of mantles (chimneys, etc). Lamps, globes, and lanterns. Operation of the Welsbach light (advantages, disadvantages, applications, etc). The first number deals with the first named of the topics). Pro Age–Oct. 1. Serial. 1st part. 2800 w.

1736. European Incandescent Lamps. D. Paisley (Results of the expiry of the monopoly of the Edison & Swan Co.'s master patents of glow lamps, with tables). Elec–Oct 2. 800 w.

*1810. Regulation of Alternating Dynamos. W. L. R. Emmet (The causes of error considered; a review of some of the peculiarities of machines used). Elec Pow–Oct. 2000 w.

1830. Researches with the Alternating Current Arc (Extract from a paper by Mr. Georges, reporting the results of experiments made by Mr. Oelschlaeger, Dr. Michalke and Mr. Queisser). Am Gas Lgt Jour–Oct. 7. 1400 w.

*1846. The Superiority of Alternating Over Continuous Current for Incandescent Glow Lamps. C. J. Robinson (Experiments made proving claims). Elec Rev, Lond–Sept. 27. 1000 w.

Power.

1314. Electrifying Zion:—The Big Cottonwood Power Transmission, Salt Lake City, Utah. Ill. George Heli Guy (Description of power station, construction, development and costs, with review of natural advantages, commercial possibilities, &c). Elec Eng–Sept. 11. 3500 w.

†1339. Electric Transmission of Power (Describes the system of electric transmission developed by the Siemens family, with illustrations of its applications). Ind & East Eng–Aug. 10. 1700 w.

1365. Electric Traction on Canals (Application of the trolley system to canals). R R Gaz–Sept. 13. 500 w.

1388. Electric Power in the Operation of an Important Cable Road. Ill. (At the 52d and State St. power house of the Chicago City Railway Co. Undertaken in the hope of reducing operating expenses). Elec Ind–Sept. 1200 w.

1443. The Storage Battery Question (Editorial. Argument favoring the ultimate success of storage batteries). Pro Age–Sept. 16. 900 w.

1529.—$1. Compounding Dynamos for Armature Reaction. Ill. Elihu Thomson (A paper calling attention to a type of dynamo in which there is no series winding, though the machine is in effect compounded, or over-compounded at will). Trans Am Inst of Elec Eng–June & July. 2200 w.

1530.—$1. Electric Power in Factories and Mills. F. B. Crocker, V. M. Benedikt and A. F. Ormsbee (Practical tests with favorable conclusions. Discussion). Tr Am Inst of Elec Eng–June & July. 1100 w.

1537. Accumulator Traction. Maurice Barnett (The author predicts a speedy and wide development of the system, and that it will play no insignificant part in the future history of electric traction in this and other countries). W Elec–Sept. 21. 2500 w.

1539. The New Storage Battery Plant of the Boston Edison Company. Ill. W. S. Key (Historical account, and description of battery). Elec Eng–Sept. 18. 1600 w.

1553. Power Consumption by Electric Railways. A. K. Baylor (Read before the Penn. St. Railway Asso. Considered in its relation to the electrical apparatus). Elec Rev–Sept. 18. 2500 w.

1568. Generation and Distribution of Electric Power for Manufacturing Purposes. C. A. Stone and E. S. Webster (Abstract of a paper read before the New England Cotton Mfrs.' Asso. Five cases where electric power can be used to advantage, with consideration of cost). Elec Eng–Sept. 25. 1800 w.

1572. Economical Equipment and Operating of Power-House. H. S. Newton, with Discus-

sion (Read before N. Y. State St. Ry. Asso. Ways and means adopted in the power-house at Syracuse). Elec Ry Gaz-Sept. 21. 3300 w.

1574. Signals on Electric Railways. J. H. Barnard (Read at N. Y. State St. Ry. Con. Signals considered important, with reasons). Elec Ry Gaz-Sept. 21. 1400 w.

*1599. Two of Chicago's Greatest Railway Power Plants. Ill. (Detailed description of the Western Avenue, and California Avenue electric power plants). St Ry Rev-Sept. 15. 2000 w.

*1613. Approximate Analysis of the Use of Coal in an Edison Electric Station of the Type Standard, about 1890. R. S. Hale (A very able paper. Describes the plant in which the analysis was made, the method employed, and illustrates the text with numerous load diagrams). Jour Asso of Eng Soc-Aug. 3300 w.

*1705. The Modern Application of Electricity to Traction Purposes. Philip Dawson (Read before Section G of Brit. Asso. The advantages set forth, different systems considered and favorable conclusions drawn). Elec Rev, Lond-Sept. 20. 5500 w.

†1731. Harnessing the Tides. George E. Walsh (Considering the possibility of utilizing the power of the tides for generating electricity). N Am Rev-Oct. 1300 w.

1861. The Portland, Ore., Light and Power Distribution from the Willamette Falls. Ill. (Description of the turbines, system of distribution, generators, switchboards, line, etc). Elec Eng-Oct. 9. 3300 w.

Telephony and Telegraphy.

1370. Mercadier and Auizan's Combined Urban and Long-distance Telephone. Ill. (Descriptive). W Elec-Sept. 14. 900 w.

1371. Ruling of Patent Commissioner in Important Telephone Controversy (A summary of the points raised in the Scribner-Kellogg controversy over the multiple switchboard patent. An important decision interesting to telephone men). W Elec-Sept. 14. 4500 w.

*1387. Repairing Underground Telegraph Cables in West Africa (An unique engineering experience). Elec, Lond-Sept. 6. 1800 w.

1536. Telephones and Telegraphs at the Chicago Board of Trade. Ill. (Principally descriptive of the telephone installation). W Elec-Sept. 21. 1600 w.

*1701. Some Lessons in Telephony. A. R. Bennett (A general review of the telephone systems in all the European countries, with map, and a tabulated statement of the countries, population, number of exchange telephones, number of persons to each telephone, characteristics of management and order of merit). Ind & Ir-Sept. 20. 3200 w.

1721. "Token" Telephone Service. Ill. (President Morris F. Tyler, of the Southern New England Telephone Co., devises an ingenious pay system which promises to become popular. Descriptive). Elec Rev-Oct. 2. 1000 w.

*1783. Pioneers of [Electric Telegraphy. Arthur Shippey (Historical review). Elec, Lond-Sept. 27. 2800 w.

*1845. The Development of the Telephone Service in Agricultural Districts. C. E. Webber (The neglect of rural telephony in England. A consideration of the requirements, costs, advantages, etc.). Elec Rev, Lond-Sept. 27. 3600 w.

Miscellany.

*1303. The Late Franklin Leonard Pope. Editorial (Obituary and biographical). Eng Mag-Nov. 2000 w.

1315. On Magnetic Potential. Frederick Bedell in the Physical Review (Mathematical). Elec Rev-Sept. 11. 1100 w.

1316. A Plea for Better Construction Work. Keppele Hall (Points out defects, and describes requirements for good work. An instructive article to non-expert users of electric lighting plants). Elec Wld-Sept. 14. 2500 w.

1317. An Electrolytic Process for the Manufacture of White Lead. R. P. Williams (Read before the Am. Chem. Soc. Description of process. Arthur B. Brown the inventor of the process). Elec Wld-Sept. 14. 1800 w.

†1322. Marvels of Electricity, in Light, Power, Therapeutics, Physics, and Operations Deemed Impossible by Colleges. Joseph Rodes Buchanan. Arena-Sept. 7800 w.

*1393. On Self-Acting Compensation for Temperature in Standard Cells. Albert Campbell (Three methods of getting rid of the correction for temperature in the Clark cell). Elect'n-Sept. 6. 1400 w.

*1394. The Magnetic Field of a Rectangular Current. G. M. Minchin (A paper giving the expression for magnetic force per unit pole at any point in the plane of a given rectangle when this rectangle is traversed by an electric current). Elect'n-Sept. 6. 800 w.

*1395. The Variation in the Electrical Resistance of Bismuth, When Cooled to the Temperature of Solid Air. James Dewar and J. A. Fleming (Abstract from Phil. Mag. Observations showing that there is a very marked difference in samples of bismuth as regards electrical resistance when subjected to very low temperatures, and that its behavior at these temperatures in magnetic fields is abnormal). Elect'n-Sept. 6. 2700 w.

*1396. A Theory of the Synchronous Motor. W. G. Rhodes (Paper read before the Physical Soc. Mathematical. The author claims originality in his method of attacking the problem). Elect'n-Sept. 6. 2000 w.

*1522. On Some Modern Voltaic Cells of High Electro-motive Force. Desmond G. Fitzgerald (Consideration and test values of various cells, with comments). Elec Rev, Lond-Sept. 13. 2000 w.

*1524. Health Precautions in Accumulator Factories. F. E. Everard (Additional facts and precautions supplementary to the suggestions of Dr. Schoop in issue of Sept. 6th). Elec Rev, Lond-Sept. 13. 500 w.

1525.—$1. Properties of Fuse Metals when Subjected to Short Circuits. Walter E. Harrington (Description of tests from which the author concludes that fuse metals are under no cir-

cumstances to be considered in the light or nature of a protection.—Discussion). Trans Am Inst of Elec Eng–June & July. 7000 w.

1526.—$1. Theory of the General Alternating Current Transformer. Charles P. Steinmetz (Description with equations in complex quantities. Discussion). Trans Am Inst of Elec Eng–June & July. 3000 w.

1527.—$1. Location of Grounds in Armatures, Fields, etc. Ill. Clarence E. Gifford (Methods described which the author has found to be rapid, accurate and simple). Trans Am Inst of Elec Eng–June & July. 3000 w.

1531.—$1. Some Features of Alternating Current Systems. Charles Proteus Steinmetz (A review of the work done in the last few years in exploring the actions and reactions of alternating currents). Tr Am Inst Elec Eng–June & July. 5000 w.

1532.—$1. Some Observations on a Direct Connected 300 K. W. Monocyclic Alternator. Dugald C. Jackson and S. B. Fortenbaugh (Description of machine with results of observations. Discussion). Tr Am Inst Elec Eng–June & July. 1700 w.

1533.—$1. Phasing Transformers. Ill. Charles S. Bradley (A description of an arrangement of condensers and cores to produce polyphase and single phase alternating currents). Tr Am Inst Elec Eng–June & July. 3300 w.

1534. Electrical Ottawa. Ill. (A description of some of the electrical features of the capital city). Can Elec News–Sept. 2200 w.

1540. Insulated Wires and Their Peculiarities. A. E. Dobbs (Description of samples collected from various sources. Considers an insulation composed of a light rubber core with two asphaltum soaked braids, or a tape and braid on the outside, would make an ideal insulation for ordinary house wiring). Elec Eng–Sept. 18. 1400 w.

*1557. Molecular Electricity. J. H. Poynting, with Editorial (A careful consideration of the subject starting with the hypothesis that electrical and chemical forces are identical, &c.) Elect'n–Sept. 13. Serial. 1st part. 5400 w.

*1559. The Invention of the Electromagnet. E. Boistel (From *L'Éclairage Électrique*. A reply to M. G. Pellissier). Elect'n–Sept. 13. 2200 w.

1624. Electric Carriage with Fulmen Accumulators. Ill. (Data furnished by Mr. Jeantaud to *Revue Industrielle*, relating to his electric carriage and its performance in the recent Paris-Bordeaux race). Sci Am Sup–Sept. 28. 1400 w.

1628. Electric Welding and Soldering by Dr. Zereuer's Process. Ill. (The fourth and latest process. Three previous ones briefly described and their objections claimed to be overcome by Dr. Zereuer). W Elec–Sept. 28. 1200 w.

1629. Electrical Recording Instruments of the Weather Bureau. Ill. Elisha C. Vose (A brief description of instruments in general use at stations of the first order). Elec Wld–Sept. 28. 1300 w.

*1651. Some Points in the Manufacture of Vulcanized India-Rubber Covered Cables and Wires. Ill. J. Warren (Especially interesting to those engaged in cable-making. Care in the manipulation of India-rubber). Elec, Lond–Sept. 20. 700 w.

*1703. Storage Batteries. H. A. Earle (Read in Sec. G. of Brit. Asso. A general outline from a practical point of view. Brief historical review, with interesting features connected with storage batteries). Elec Rev, Lond–Sept. 20. 5000 w.

*1704. Electrification and Diselectrification of Air and Other Gases. Ill. Lord Kelvin, Magnus Maclean and Alexander Galt (Abstract. Communicated to Sec. A of Brit. Asso. Experiments with results). Elec Rev, Lond–Sept. 20. 1800 w.

1709. The Electrical Patent Situation (Editorial on a circular issued by the house which controls Nikola Tesla's patents, to alleged infringers, indicating that decisions of pending suits will be momentous in their effects upon electrical industries). Pro Age–Oct. 900 w.

1749. Action of the Electric Current upon Aluminum Wire. Ill. (The behavior of aluminum wire when raised to white heat and even fused, is very peculiar; though melted, it does not break, being held in form by a sheath of aluminum oxide which forms upon its surface. From *La Nature*). Sci Am Sup–Oct. 5. 1800 w.

1781. Fires of Electrical Origin. William H. Merrill, Jr (The largest percentage caused by the crossing of telephone, telegraph and similar wires with trolley or electric light wires. The remedy. Other causes considered). W Elec–Oct. 6. 2000 w.

*1809. The Aim of Laboratory Training. W. M. Stine (A discussion with reference to the electrical laboratory training for the electrical engineer). Elec Pow–Oct. 3500 w.

*1812. Electricity in the Astronomical Observatory. Ill. J. T. Monell (Description of the chronograph, driving clock, detector, relay, &c., as used for astronomical purposes). Elec Pow–Oct. 4000 w.

*1813. Modern Uses of the Storage Battery. Max Loewenthal (A few characteristics of the chloride accumulator endeavoring to show its superiority to all existing types of storage batteries. A list of some of the applications in which accumulators are giving satisfactory results. Its use for lighting bicycles, carriages, &c). Elec Pow–Oct. 1800 w.

*1843. On Some New Methods for the Delineation of Alternate Current Wave Forms. Ill. James Mark Barr, W. Beckit Burine, and C. Rodgers (Description of an apparatus that automatically records with great rapidity the wave-form). Elec Eng, Lond–Sept. 27. 1900 w.

*1847. The Magnetic Field of a Rectangular Current. G. M. Minchin (The object of this paper is to show that the graphic rule given in a previous paper by the author, also holds for points infinitely close to the sides of the rectangle. An extension of the result to the case of a rectangular coil will also be made). Elect'n–Sept. 27. 2400 w.

INDUSTRIAL SOCIOLOGY

Successful Co-operation.

IN an address before the twentieth convention of the Iron Molders' Union of North America, Mr. Henry Cribben, one of the charter members of that association, very strongly urged the feasibility of co-operative industry, and made a powerful argument in favor of continued effort in this direction. He thinks it is not visionary to look forward to the time when the bulk of the work done in the foundry trades will be done by coöperative associations; and he outlined a scheme whereby, as he thinks, this peaceful revolution could be brought about in 25 or 30 years, believing that under this system all frugal and thrifty members would own their homes and have money in the bank for investment when opportunity offered. His plan, quoted from his address published in *The Foundry* for September, is as follows:

"First incorporate the national association in some State, or secure a charter at Washington and establish permanent headquarters in some city centrally located; resolve to avoid strikes by all possible means . . . . and save money for the purpose of fostering the coöperative movement about to be undertaken. The association to raise, by assessment upon its members, $40,000 or $50,000 annually; one half to be paid during the first 6 months, and the other half to be paid during the last six months of each year. The money to be placed in the hands of five trustees, for the establishment of coöperative machine and stove foundries in the United States, in the following manner: I will take $50,000 annually as the amount of money to be raised by taxation for the illustration. When the first $25,000 is collected, the trustees to offer to invest that amount for the period of 4 or 5 years, or more if necessary, in any city having a union in good standing whose members, individually and collectively, will subscribe an equal amount of money for stock in such foundry. The board of trustees, selected for their honesty, ability, and competency to manage such a business, to constitute a majority of the board of directors in each and every foundry so established. And, taking it for granted that each coöperative foundry so established could be placed on a dividend-paying basis almost within the first 2 or 3 years, it would be no trouble for the union to sell its stock to other parties at a premium above this outlay at the time specified, and use the money for the establishment of additional foundries of the same character in other cities, where the prospects of future successful business would present itself. We would establish in the first 5 years ten foundries, with a paid-up capital of $50,000 each, and, if successful in selling the stock of the union at the expiration of 5 years in each case where the business became profitable,—of which there is no question,—at the expiration of 10 years we would have ten additional foundries established by taxation, and the stock of the first ten foundries established during the past 5 years transplanted, with the premiums earned, elsewhere, making a total at the end of 10 years of thirty foundries; at the end of 15 years we would establish ten more by taxation, and transplant the stock of the twenty foundries established during the first 10 years, making a total at the end of 15 years of sixty foundries; at the expiration of 20 years we would establish ten more by taxation, and transplant the thirty foundries established during the first 15 years, making at the end of 20 years a total of one hundred foundries; at the end of 25 years we would establish ten more foundries by taxation, and transplant the stock of the forty foundries established in the first 20 years, making a total of one hundred and fifty foundries; at the end of 30 years we would establish ten more foundries by taxation, and transplant the stock of the fifty foundries established during the first 25 years, making a grand total of two hundred and

ten well-equipped foundries, with a paid-up capital of $10,500,000, to say nothing of the profits accruing therefrom of at least as much as the paid-up capital of the stockholders, or a grand total of capital and profits of $21,000,000, at an expense to the union in 30 years of $1,500,000.

"The above figures show conclusively that the bulk of the stove and machine business of the country would be controlled by the coöperative foundries so established in 30 years, to say nothing of the number of similar foundries that would be established by individual enterprise; and the national association would have a source of revenue that would enable it to do many things it ought to do for its membership . . . . now impracticable for want of money—such as providing for sick and death benefits, life insurance at a very low rate, and the establishment of library and reading rooms in all the leading cities of the country."

The coöperative plan was proposed by Mr. Cribben at a national convention of the Iron Molders' Union 30 years ago, but that body would have none of it, and would not listen to him. Recalling this discouraging reception of his views, and what followed, he said:

"I returned home from that meeting somewhat discouraged, but finally determined, so far as I was personally concerned, that I should at the earliest opportunity become my own employer, if I could find a sufficient number of molders in Rochester to join me, who were of the same opinion, and had money to buy one or more shares of stock; and I began at once to agitate the subject of coöperation, making converts for the new enterprise, determined to convince my associate delegates to that convention that, with $800 of my money and that of my associates, we could become our own employers and enjoy the fruits of our own labor.

"A coöperative grocery store had been in operation in Rochester for something more than a year, which had been improperly managed from the beginning to the finish, and, when we had secured subscribers for about $10,000 worth of cooperative foundry stock, the stock and fixtures of this store were about ready to be sold at auction and the money received from the same applied to pay its debts. Knowing this, I went to a directors' meeting (of the store), and informed them that their auction sale would destroy my cooperative foundry enterprise, and urgently requested them to continue their business for 2 or 3 weeks more, until I could organize and incorporate, and collect my stock subscriptions for, the foundry. They granted the prayer of my petition; we collected $11,500 of foundry stock subscriptions, and the sale of the grocery stock and fixtures took place.

"Before we had organized or secured any subscriptions to the stock, Mr. N. Brayer and myself purchased the foundry property where the office is now located for the sum of $20,000, subject to a mortgage of $10,000 on a contract, and paid $1000. On the ninth day we called for the deed, and the gentleman laughingly remarked it was not ready, seemed to be surprised to find that we had raised the money, and candidly admitted he thought we could not raise it, and that he would pocket our $1000. After making the payment, we had left $1500 to operate the foundry, which for the 5 preceding years had required something like $120,000 per annum to pay the operating expenses. There was no very encouraging outlook for our new enterprise at this time. We had collected all of the available subscribed capital that was possible; but, hearing of a party who was about to engage in the coal business, I went to see him at once, and used my best endeavors to show him the beauties and profits of the stove business, and succeeded in having him loan the company $10,000, secured by second mortgage on the plant and real estate, and we guaranteed him 7 per cent. on his money, whether the company made it or not, and as much more as it would earn in the business. We also paid him $2000 per annum for indorsing our paper discounted at the bank. There were times when the amount of our discounted paper in that bank often exceeded our total paid-up capital seven times. This gentleman remained with us about 3 years, and, when

he left us, the company paid him a trifle less than $30,000, his earnings in that time on his original investment being nearly doubled.

"This company has now a paid-up capital of $200,000, and a surplus of nearly $200,000 more, but the property and plant owned by them could not be purchased for the amount of their capital and surplus combined, as it is worth very much more."

Mr. Cribben very pertinently asks: "If such results can be accomplished by five men, with little or no capital, why . . . . could not the coöperative plan as outlined be made a grand success?"

The only answer to such a question is that the general history of such enterprises has shown that, with a few notable exceptions, schemers and manipulators, instead of honest, capable men, get control of the management. If human nature were, on the average, reliable, as in the case of the Rochester experiment, coöperative industry would be a most hopeful remedy for industrial discontent.

Old-Age Houses in Austria.

MISS EDITH SELLERS, in *The Nineteenth Century* for August, writes instructively and entertainingly of the provision made for the support of the superannuated poor in Austria. Contrary to what has been supposed by some, the institution of what are called "old-age homes" dates back to an early period. These "refuges" for "worn-out workers," as Miss Sellers calls them, are, she says, peculiar to Austria. The first was built in the thirteenth century, and was called the Langhaus.

The inmates of this home were once supported and well supported by private charity. The building was destroyed by the Turks in 1529, but another, accommodating from five to six hundred people, was erected, and "during the seventeenth century several similar institutions were founded." How these institutions became changed from mere charities into institutions to which superannuated workers might demand admittance in their own right is stated as follows:

"As time passed, the old-age homes lost, unfortunately, much of their distinctive character, and were often used as hospitals, and even as orphan asylums. The emperor, Josef the Second, however, speedily put an end to this state of things; for, if there was one work of social reform he had more at heart than another, it was that of bettering the condition of the aged poor. He was one of the first formally to enunciate the doctrine that a man who has worked in the days of his strength has the right to be supported by his fellows when old age comes upon him. By the Poor Law which he drew up for his subjects, it is enacted that any person who is destitute may, at the age of sixty, claim from his commune either free board and lodging, or a pension equal in amount to one-third of his previous average annual earnings. And this was to be granted to him, not as a favor, or as charity, but as a right. The Vienna poor-law regulations of to-day, in so far as they relate to the treatment of the aged, are founded on this statute."

As the law now is, "all persons who have a right of settlement in Vienna—*i. e.*, about 36 per cent. of the inhabitants—may, on or after their sixtieth birth-day, claim either a pension, or admission to an old-age home, always providing they cannot support themselves, and have no relatives who are bound legally to support them. As, however, there is room in these institutions for only some 4600 persons, and there are usually more than four times that number who wish to live there,—the pensions are now miserably small,—the Poor Law authorities are vested with a certain discretionary power in deciding who shall, and who shall not, be admitted. And, so far as possible, the preference is given to persons of good character, to those whose destitution is the result of their misfortune, not their heedlessness or extravagance. The great majority of the inmates of these homes, therefore, belong to the respectable poor class. Thus no disgrace is attached to going there: an Austrian would no more think of being ashamed that his father was in an old-age home than an Englishman would be that his had rooms in Hampton Court. One reason why old people in England dread

going to the workhouse is the knowledge that, when they have once crossed its threshold, they will be regarded as pariahs even by their nearest relatives."

Some of these homes are directly in the city; others are located a little way out in the country. A description of a typical one follows, which we can only epitomize. The sleeping rooms are large and lofty, each containing twenty comfortable beds. The inmates are permitted to take in personal belongings, and thus they give the rooms a homelike aspect. "In summer the rooms are gay with flowers. . . . . The corridors are furnished with comfortable settees." Daily papers are subscribed for. The men and women sleep in separate rooms, but otherwise are not separated.

The most unique feature is the method of supplying food. Each inmate is furnished with 26 kreutzers daily, and with this sum buys his own food, at a restaurant specially kept for the accommodation of the pensioners. The food, it is stated, is good, yet the restaurant is self-supporting. The food and its cooking are subjected to medical inspection before it can be served, and there is nothing else to distinguish this restaurant from others usually frequented by artisans in Vienna. Inmates are permitted to earn money as they can find opportunity. Each is required to maintain neatness and cleanliness of person and dress. The authorities encourage them in adding to their allowance by earning money, and even give them opportunities for it. If any one is prone to use his money in excessive drinking, or otherwise foolishly, his stipend is cut off, and he is put on rations. Altogether (we have not mentioned the half of the commendable features described by Miss Sellers) these institutions seem to be very much in advance of any others having similar objects of which we have ever heard or read.

Wages in France.

ABSTRACTS of consular reports afford material for a statement of wages paid to workmen in different branches of industry in Paris and the Department of the Seine, in France, which, together with details relating to the condition of the metal industries, are compiled into an interesting statement printed in *The Engineer* (Sept. 6).

In the metal group the industries dealt with are those working metals already extracted from the mineral, and include copper foundries, machine works, rolling mills, tinplate works, wire works, etc. Machinery plays an important part in the working of the common metals, but, owing to the diversity of the products manufactured, the power employed varies widely. Some of the largest and most important works are to be found in these industries, but small shops, and even employees who work at their homes, are abundant. While 100 h. p. per one hundred hands is used in rolling mills, the other industries, except wire works, do not ordinarily use more than 25 h. p. for the same number of hands, and there are many shops where no mechanical power is used. The employees of this group differ widely in respect to the intelligence and skill they are required to exercise. Those working without the aid of machines, such as coppersmiths, fitters, locksmiths, tinsmiths, etc., often possess a high degree of intelligence and skill, their trades requiring them to execute work from designs or by processes the learning of which has required a long apprenticeship and much experience. Those who work with machinery may be divided into those who follow occupations which demand a knowledge of design and a long experience in the trade, together with intelligence and skill in proportion as their machines are complicated, and those who carry on operations which are always of the same character, requiring neither intelligence or skill, who do not make the tools they work with, and consequently are unskilled laborers, called upon merely to acquire a certain degree of dexterity and watch the machines. The latter class have been more or less displaced by women and children, who average 5 per cent. of those employed in iron and steel works and 20 per cent. of those in rolling mills. Except in the manufacture of iron for constructive purposes, the industries of this group rarely work on Sundays. In certain

cases where the work on hand is pressing, some workmen may come to the shops for half a day on Sunday, but seldom for the whole day.

The average number of days of production for the whole group is 303. The average number of working days per hand in the iron industries ranges from 1 per cent. to 9 per cent. less than the days of production; the greatest average loss of time in proportion to production in the manufacture of brass and copper for building purposes, and in brass foundries, amounts in the first instance to 15 per cent. The average duration of a day's work varies from 9¾ to 10¾ hours, the average being 10½ hours. In iron works a day varies from 9 to 12 hours, but is rarely the former, being most frequently from 10 to 12 hours. In constructions in iron the day varies according to the season, sometimes being 9 hours and sometimes 11 hours. In rolling mills the hours are 10, 11, and, most frequently, 12, with exceptions of 8 or 9 hours. In iron furniture and wire works the hours are 11, and exceptionally 10. In boiler works the time varies from 10 to 11 hours generally, with exceptions of 9, and sometimes 12 or 13, hours. In iron foundries the hours are 10 or 11. In machine works the day varies from 10 to 11 hours, with rare exceptions of 8 or 12 and more hours. In copper works and foundries the hours are ordinarily 10 and 11, rarely 9 or 12. In the manufacture of faucets and other articles in brass the day is 10 to 11, with exception of 12 hours. Brass and copper works and manufactories of iron for building purposes have their season of greatest production during the summer and autumn months.

Ordinarily, in these industries, the occupations requiring the greatest intelligence and skill are the ones in which wages are highest, but production is an important factor in certain cases, and it sometimes happens that workers turning out certain products in large quantities by mechanical means receive as much as, or even more than mechanics whose occupations require intelligence, knowledge of design, and skill, such as fitters, for example, who cannot work by the piece.

It is impracticable to give here the entire schedule of wages for all occupations; a general inference of the relation that wages in France bear to those in other lands may be formed from wages paid to blacksmiths and machinists, a schedule of which follows:

Occupations.	Time or piece work.	Average wages per day 10 hours. s. d.	s. d.
IRON INDUSTRIES.			
Blacksmithing, rolling mills, bolt, axle, and spring making—			
Boltmakers	Piece	3 2⅝	— 4 4⅜
Blacksmiths	Time	4 4⅜	— 5 0
"	Piece	3 7½	—17 7¼
Boys	Time	0 10½	— 3 0
Catchers	Piece	5 7½	— 6 4⅜
Clippers	Piece	2 9⅜	— 4 0
Roll turners	Time	12 9⅜	
Fagot hands	Piece	4 0	— 5 0
Feeders	Time	4 4⅜	— 5 0
Filers	Piece	4 9⅜	— 6 4⅜
Firemen	Piece	4 0	— 4 9⅜
Fitters	Time and piece	4 0	— 9 7½
" helpers	Piece	3 2⅜	— 4 0
Foremen	Time	7 7½	—16 0
Forge hands	Piece	3 2⅜	— 4 4⅜
Furnace hands	Time and piece	3 2½	—18 2⅜
" helpers	Time and piece	4 0	—11 2⅜
Hammerers	Time	14 6¾	
Machinists	Time and piece	6 0	—18 9¼
Moulders	Piece	5 7½	— 8 9⅜
Mounters	Piece	4 9⅜	— 6 4⅜
Polishers	Piece	5 3¼	
Punchers	Piece	1 2½	— 2 0
Reducing rollers, before	Piece	6 4⅜	— 7 8¾1
" behind	Piece	5 9½	— 6 4⅜
Rollers	Piece	5 7½	—10 4⅜
"	Time	5 2½	—10 0
Rounders	Time	4 0	
Sawyers	Time	4 7⅝	— 6 2⅜
Spring makers	Time	5 2½	
Strikers	Time	2 4½	— 5 2⅜
"	Piece	2 4½	— 5 4⅞
Temperers	Piece	6 0	
Thread cutters	Piece	2 9⅜	— 4 0
Machinery construction—			
Counter sinkers	Time	6 0	— 9 7½
Fitters	Time and piece	1 2⅜	— 9 7½
Foremen	Time	6 4⅜	—19 2½
Machinist electricians	Time	4 8⅝	— 6 0
Machinists	Time	2 0	— 8 0
"	Piece	2 4⅜	— 9 7¼
Modellers	Time	4 0	— 7 2⅜
Moulders	Time	5 8	
Planishers	Time and piece	6 0	— 9 7½
Rivetters	Time	5 11	
Setters-up	Time and piece	4 4⅜	— 8 0
Smiths	Time	4 9⅜	—10 4⅜
"	Piece	5 2½	—10 4⅜
Turners	Time	3 4¾	— 7 7½
"	Piece	4 0	— 9 7½

Inheritance of Property a Social Evil.

THE opinion that the inheritance of property is wrong in principle, and that the power to bequeath wealth ought to be either restricted or abolished altogether, is not new. It has been frequently discussed. The right of the living to control the disposal of wealth before death is the main theoretical obstacle in the way of abolishing testamentary disposal of property, and it appears to us that the latter could not effectually be prevented without at the

same time abolishing the former. For, if a man can actually divide up his estate among those whom he wishes to benefit before he dies, it would, while affecting himself somewhat differently, have the same effect upon the tenure of the heirs and upon the distribution of the property after his death. The social effects of such disposal of estates would be in no wise different from their disposal by will, except, perhaps, that lawyers might find less to do. Doubtless, however, there would be an increase of litigation over the disposal of property before death.

No less conspicuous a writer than Nordau has, however, championed "the abolition of the artificially-created right of inheritance." The words are quoted from *The Journal of Gas Lighting*, a journal that has of late dealt much and ably with social questions, and which reviews, in the issue named, Nordau's latest work, "Conventional Lies of Civilization." Nordau says:

"The causes of modern revolutions are not constitutions on paper and democratic party cries, but the longings experienced by so many to toil less and live better." It is not, says the *Journal of Gas Lighting*, as Nordau is careful to show, "that the majority of the people now living under civilized conditions are absolutely poor. On the contrary, as compared with their forefathers, they are much more comfortably circumstanced. The trouble arises from the undoubted fact that they are relatively poorer, in comparison with the rich of their own epoch, than the tillers of the soil, the hewers of wood and drawers of water, who were their predecessors. This Nordau puts to the discredit of the modern growth of the city and the factory." Nordau says that "this is the point to which all the countries of Western Europe have arrived,—countries considered to be the wealthiest and most highly civilized in the world. Their population is divided into a small minority living in the midst of an aggressive and extreme luxury, and a vast number consisting of persons who can support life by the hardest exertions, or who, in spite of all their efforts, find it impossible to attain to a normal human existence. . . . Never before were there so many persons entirely without possessions as at the present time." The "appropriation of the results of others' labor, not one's own," is the cause, in Nordau's opinion, of all this "inequality of distribution." "When the real estate inherited by a certain man increases in value, it is not the result of his own exertions, but of the fact that the number of workingmen torn from the land and soil is constantly increasing, that all forms of industry are growing in extent, that the cities are becoming more and more populous, that the labor of civilized society is being confined more and more to manufacturing industries, thus causing the price of provisions to rise in the same proportion as the price of manufactured articles is falling,—in short, because other men are working, not because the landed proprietor exerts himself. When the speculator amasses millions, it is by the abuse of a superior strength, either of information, sagacity, or of combination, with which he deprives the laboring and saving classes of their property, just as the brigand relieves the wayfarer of his purse, first knocking him down with his club. When the manufacturer becomes a Crœsus, it is by systematic plundering of his workmen, who receive, for their exertions in his behalf, nothing more than food and shelter, like so many domestic animals, and both the scantiest possible. The entire results of their labors flow into the money-bags of their master."

"When a man accumulates a fortune, he wishes to bequeath it to his family in such a way that its members will be, if possible, relieved forever from the necessity of earning their own livelihood. This is contrary to nature's laws. It is a violent disturbance of the regular arrangement of the world, according to which every living being is compelled to win for himself his place at the great table of nature, or perish. This disturbance of nature's regulations is the cause of all the evils of the economic world."

Yet we shall find, if we examine into the subject, that a very large number of the wealthiest people did not gain their estates by inheritance, and large estates are con-

stantly dissipated by those who inherit them. The capacity to amass implies the power to keep, after gaining, wealth. Those who inherit property rarely inherit the ability to amass or to keep wealth, and these talents, even if inherited, not being cultivated, after a generation or two cease to be transmitted. When a social economist finds in any one thing the sole cause of all existing social evils, it seems that his mental vision must be narrow.

THE Bankers' Magazine for October says the Bank of New Zealand is again in need of assistance. In ordinary times this would have attracted considerable attention, and perhaps caused weakness in the colonial market. Nowadays no one thinks of anything but "Kaffirs," and colonial stocks were entirely unaffected. The telegrams on the subject are rather vague, and it is impossible to deal fully with the matter until adequate details have been received by mail; but it appears that the parliamentary committee appointed to inquire into the company's position found that the banking deficiency amounted to £377,000, the contingent deficiency to £200,000, and the Estates Company's deficiency to £1,340,000.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Industrial Sociology in the American, English and British Colonial Technical Journals—See Introductory.

*1304. The Currency Problem and Its Solution. Abraham Mills (Showing that the United States government ought to borrow gold in London, redeem therewith the greenbacks, and retire from the banking business). Eng Mag-Nov. 3200 w.

*1305. Taxation in the United States. Edward Atkinson (An analysis showing the burden of taxation per capita in the United States, with a view to stimulating economists to a study of the comparative taxation of different countries). Eng Mag-Nov. 4000 w.

†1321. A Visit to Broken Hill. Moreton Frewen (The industrial value. Industries dependent on this camp, &c). Contemporary Rev-Sept. 1800 w.

†1323. The Labor Exchange. F. W. Cotton (The central provision of the Labor Exchange is the certificate of deposit which enables people to conduct business without resort to legal-tender money. Its advantages). Arena-Sept. 750 w.

1349. Agriculture and Shipping—A Movement to Secure for them Equitable Protection (Gives a history of the so-called "Lubin" proposition to have the government pay a bounty on agricultural exports and of the adoption of this proposition as a plank in 1894 by the Republican party in California; and also of the initiation of a co-operative movement between the shipping interests and the agricultural interests, whereby each is now endeavoring to obtain the adoption of a national bounty system both working in harmony for these ends. The aims sought, the means adopted to further the project, and its present status). Sea-Sept. 12. 10800 w.

*1381. A Party with a Future. J. Louis Garvin (The Independent Labor Party in England, otherwise called "Laborists." This prediction is based on the results of the last general election. The further prediction is made—with reasons assigned—that the socialistic movement will be a power in the general election of 1900). Fortnightly Rev-Sept. 6000 w.

†1382. The Climax of Agricultural Disaster. William E. Bear (Calling attention to the peculiar bad luck of the agricultural classes in England, in the shape of the bitter disappointment which they have suffered time after time when they had apparently had reason to hope for some improvement in their condition). Fortnightly Rev-Sept. 4200 w.

†1383. The Awakening of China. M. Rees Davies (A review of China's attitude in the past, its present position and outlook for the future. The commercial aspect). Fortnightly Rev-Sept. 5400 w.

†1397. The Present Condition of Russia. Prince Kropotkin (The need of thorough reconstruction. The problems to be met). Nineteenth Cent-Sept. 8000 w.

*1421. Continental versus English Workmen (Editorial. An interesting contrast). Ir & Coal Tr Rev-Sept. 6. 2000 w.

*1429. Abstracts of Consular and Diplomatic Reports (France: Wages in Paris and Department of Seine). Eng. Lond-Sept. 6. 1300 w.

*1434. Address of R. T. Crane to His Workmen (A comparison between manufacturing industries forty years ago and those of today. Relations of the employers to the employed). Dom Engng-Sept. 5000 w.

*1466. Mr. George Livesey Interviewed (An interesting account of profit sharing, given by the chairman of the South Metropolitan Gas Company, in which this system and other reforms have been satisfactorily introduced). Gas Wld-Sept. 14. 1600 w.

1475. Co Operation. Henry Cribben (An exceedingly interesting and instructive paper read before the 20th convention of the Iron Molder's Union of North America. Gives a history of the organization, progress, and present condition of the Rochester Co-operative Foundry. A remarkably successful social experiment). Foundry-Sept. 6000 w.

We supply copies of these articles. See introductory.

*1510. The Trades Union Congress (Editorial review of proceedings of the 28th congress of what is called the "Labor Parliament," with general remarks upon these congresses. Disapproves certain socialistic resolutions, although admitting that the general character of the proceedings commands respect). Engng-Sept. 13. 2100 w.

*1582. Commercial Relations between Germany and the United States (The appointment of a commercial agent, who has been attached to the German Consulate-General at Chicago. The appointment made in order to afford facilities to business houses and manufacturers in Germany to form connections and to extend their business in the United States). Board of Tr Jour-Sept. 2000 w.

*1583. The Economic Condition of Uruguay (Based on a report of Her Majesty's Consul at Montivideo. Official statistics are always twelve months in arrear. The figures given for 1894 are not official but may be relied upon as correct). Bd of Tr Jour-Sept. 1600 w.

*1584. New Trade Market in China (Interesting account of a new trade market which has recently been opened in China, at Yatung, in Thibet). Bd of Tr Jour-Sept. 2500 w.

*1585. Tariff Changes and Customs Regulations (Russia, Sweden & Norway, Belgium, France, Switzerland, Spain, Italy, Greece, Morocco, United States, Uruguay, British India, Canada, Cape of Good Hope, and Victoria (Australia). Bd of Tr Jour-Sept. 8500 w.

1626. Tramps as Human Beings. Morrison I. Swift, in *The Outlook* (An account of an experiment in giving employment to tramps as compared with another involving stringent penalties. The humane system said to be satisfactory and successful). Sci Am Sup-Sept. 28. 1400 w.

1627. The Thumb as an Initial Factor of Civilization. W. R. Whitehead (A very interesting speculation in which the power given to the human hand by the thumb, superior to that of the anthropoid apes, is considered one of the most potent factors in the elevation of the human race above the brute creation). Sci Am Sup-Sept. 28. 3200 w.

*1638. The Present Aspect of the Silver Question. Charles S. Fairchild (The author considers the situation encouraging to those known as "sound money" men, and cites signs in support of his opinion. He concludes that safety lies only in the severing of Government from currency to the utmost extent possible). Forum-Oct. 1500 w.

*1640. Demand and Supply Under Socialism. W. H. Mallock (An article examining the case of supply and demand, and the effect which the relation of these two factors has on values, prices and wages. Also showing that a society in which socialistic principles were developed would only aggravate the evils it aimed to correct). Forum-Oct. 8400 w.

†1669. How Men Become Tramps.—Conclusions from Personal Experience as an Amateur Tramp. Josiah Flynt (Causes or sources as understood by the author, stated, and remedies suggested). Century Mag-Oct. 4400 w.

†1670. The Marriage Rate of College Women. Milicent Washburn Shinn (A discussion of the facts of celibacy among college women. It may be a movement toward higher standards in marriage. No need to doubt that all good knowledge is safe in the long run for all men and women). Century Mag-Oct. 2500 w.

1718. The Treasury Situation and Congressional Action (Editorial, discussing the present financial situation and analyzing it. It declares that after the November elections the country will insist upon the abandonment of the policy of makeshifts, and upon legislation retiring legal tenders, which are an ever present menace to the maintenance of the treasury gold fund). Bradstreet's-Sept. 28. 600 w.

1719. The Bond Syndicate in History (Editorial reviewing the history of the bond syndicate, now terminated, which is characterized as one of the most unique, daring and comprehensive operations in the annals of finance). Bradstreet's-Sept. 28. 1800 w.

1720. The Quantitative Theory of Money Exposed (Editorial. Combats the theory that prices are regulated by quantity of money, contending that what does regulate prices is the state of credit). Bradstreet's-Sept. 28. 1200 w.

†1724. The Atlanta Exposition. W. Y. Atkinson (Some of the things which make the exposition worth visiting, even by those who have visited all past expositions). N Am Rev-Oct. 3600 w.

†1726. Some Problems of the Age. F. W. Farrar (Some of the problems and perils of this century, interestingly portrayed. The author concludes that the regeneration of society must come from individuals). N Am Rev-Oct. 3500 w.

†1727. The Microbe as a Social Leveller. Cyrus Edson (Teaching the truth that all men are dependent on each other; illustrated not only by prosperity, but disease, industrial development, &c). N Am Rev-Oct. 2500 w.

†1729. Is Socialism Advancing in England? W. G. Blaikie (Socialism, in its new aspect explained and its object stated. Concludes that in the sense used in this article it is not advancing). N Am Rev-Oct. 5000 w.

*1732. The Carnegie Libraries. William B. Shaw (Notes on a popular educational movement in "the greater Pittsburgh," with illustrated descriptions of the Carnegie free libraries of Allegheny and Braddock, and Carnegie library, music hall, art gallery and museum of Pittsburgh, which together form a complete library system). Rev of Rev-Oct. 4500 w.

*1733. The Civil Service Problem in Australasia. P. R. Meggy (Outline of a report of the New South Wales Civil Service Commission presented to the British Parliament, June 18, 1895. A very instructive article). Rev of Rev-Oct. 4500 w.

*1746. The Greenback Issue Is Returning. Jesse H. Jones (Predicts that the greenback question will soon again become prominent; de-

clares that the "free silver movement" is a blind lead on a false scent; asserts that neither greenbackers, nor gold men have perceived their own errors, and have never refuted the truth maintained by their opponents; defines what the greenback really is, and presents its advantages). Soc Ec-Oct. 2200 w.

*1747. Protection by Bounty. Alexander R. Smith (An argument in favor of the so-called "Lubin proposition," with an editorial reply exposing its fallacy and the folly of adopting it. Those who wish to study both sides of the question will find the main arguments for and against protection by bounty, well and briefly put forward). Soc Ec-Oct. 2800 w.

*1748. Broader Trade Unionism (Takes the Position that trade unions are "not a social excrescence to be eliminated, but a social institution to be utilized and broadened." Indicates lines upon which their intellectual, social and moral expansion may be realized). Soc Ec-Oct. 2800 w.

†1752. War as a Factor in Civilization. Charles Morris (This paper maintains the contention that war has done more to advance civilization than the arts of peace). Pop Sci M-Oct. 6000 w.

*1762. Steam and Electricity—A Study in Sociology. A. A. Johnson (An attempt to seek a solution of the twentieth century problem, which the author terms "The World's Social Crisis. A consideration of the economic struggles and present social conditions). Am Mag of Civ-Oct. 7000 w.

*1763. The Decadence of Home-Ownership. H. L. Bliss (A reply to article by Gilbert L. Eberhart, published in the March number). Am Mag of Civ-Oct. 2300 w.

*1764. An Automatic vs. a Fiat Currency. E. L. Rector (Money defined; what determines its value; how value is secured; the two systems explained and contrasted). Am Mag of Civ-Oct. 6800 w.

*1765. A Financial Predicament. Henry B. Russell (Calling attention to influences affecting finances, and making some calculations as to federal finances under existing conditions of the new tariff). Am Mag of Civ-Oct. 2500 w.

*1766. The Single Tax: A Reply to Mr. Kitson. George Bernard (Pointing out obvious errors and setting forth what the author conceives to be a correct statement of some of the points at issue). Am Mag of Civ-Oct. 5500 w.

1775. How Strikes May Be Avoided (Describes the system of dealing with workmen and employés, in two cotton mills in Malaga, Spain, which is claimed to be a very striking example of how strikes may be avoided by obedience to the law of kindness. Abstract from report of David N. Burke, U. S. Consul at Malaga). Mach-Oct. 1700 w.

1784. Increasingly Favorable Clearings Totals (A tabulated statement of bank clearings at eighty-six cities for the month of Sept., for eighty-four cities during nine months respectively in 1894 and 1895, and for sixty-eight cities for four years. The most encouraging bank statement since the panic of 1893). Bradstreet's-Oct. 5. 800 w.

1785. The National Finances (An optimistic view, contributed by Worthington C. Ford, who believes that unless something very unexpected happens, there will be no deficit in the national revenues in the fiscal year ending June 30, 1896. A lengthy and able argument sustaining this view is presented). Bradstreet's-Oct. 5. 2000 w.

1786. Smaller World's Wheat Stocks than on July 1 (A tabulated statement showing that on Oct. 1, 1895, the available supplies of wheat in the United States, Canada and Europe and afloat for Europe, was only about two-thirds that on Oct. 1, 1894). Bradstreet's-Oct. 5. 800 w.

1787. The Australasian Banking Crisis (A survey of the history of this crisis, which reached its acute stage in 1893, and a review of the present status of Australian banks and banking). Bradstreet's-Oct. 5. 1000 w.

1831. The Management of Men. Herbert M. Ramp. (Shows that the tendency to specialism in molding is having a deleterious effect on the minds and habits of molders, and that want of mental occupation given by variety of work, is degrading the standard of molders. Also deals with the subject of apprenticeship and treatment of apprentices). Ir Tr Rev-Oct. 3. 2000 w.

*1855. The Average Wages of British Workmen (Review of a report on this subject issued by the Board of Trade). Engng-Sept. 27. 2800 w.

†1865. Why the Workers Want. Robert Grieve (An article proving that wages bear no necessary or constant relation to the profits of business. Setting forth the wrongs due to monopolies. Examples of the power of capital, and its tendency to result in socialism). Arena-Oct. 3600 w.

†1866. Woman's Discussion of the Labor Problem. I. Land and Money. Julia A. Kellogg. II. Solution of the Labor Question. Charlette P. Stetson. III. The Great Neighbor. Alice T. Post (The opinions of representative women on social problems. A Symposium). Arena-Oct. 3800 w.

†1867. The Significance of Labor Day. Eugene V. Debs (A brief consideration of the design of all holidays, and the endeavor to point out the best use for wage-earners to make of Labor Day). Arena-Oct. 1800 w.

†1868. Manual Training for Women and the Problem of Domestic Service. G. Vrooman (An account of the schools of this character in Europe—Switzerland leading in the number and excellence of the schools—France not far behind. The advantages of such schools set forth. The present unfortunate condition of inefficiency in domestic service, due to its never having been dignified as a trade, etc.). Arena-Oct. 3200 w.

†1869. Industrial Reform. James G. Stevenson (Suggestions given in the hope of presenting a programme of industrial reform in which all classes of society may unite). Arena-Oct. 2000 w.

†1886. The Regulation of Prices (Editorial. The great need of disposing of goods at prices which will save the producer from loss. The natural tendency of prices is downward. Some suggestions to aid the seller in getting the value of his goods). Ind Rub Wld-Oct. 10. 1500 w.

MARINE ENGINEERING

Education of Naval Engineers.

IN the *Journal of the American Society of Naval Engineers* for August, Passed Assistant Engineer F. L. Bieg, U. S. N., discussed the necessity and value of scientific research in naval engineering matters as related to the United States navy, and the necessity of an engineering training for the younger members of the engineer corps. This paper appears to have been of sufficient interest to call out a very thorough discussion of the proposition made in it, which is, in substance, the establishment of a government experimental station, or school, modeled somewhat after the English naval experimental station, but on broader lines. The establishment of such a station would be far-reaching in its effect upon both the navy and the merchant service; and, as the approval given to the proposal by members of the society indicates that a determined effort to have it carried out is likely soon to be made, we quote the outline of the scheme as set forth by the author of the paper.

"The school should be at some place where there is still and deep water (as many of the experiments will be made with boats) and at a reasonably convenient distance from the manufacturing and engineering centers. There should be an engineer officer of rank in charge, under the immediate direction of the chief of the bureau of steam engineering. To put this school in a navy yard, where the officers attached to the yard are subject to all kinds of duty, would load it with useless routine and be disastrous to good results. As the experimenters are to be engineer officers, it would be just as well to encourage *esprit de corps* and stimulate the efforts of individual engineers by putting them directly under officers of their own profession, thoroughly conversant with the engineering needs of the service. With the officer in charge, who might be styled the director, should be associated two or three officers, whose duties will be defined further on. The number of officers will, of course, depend on the other demands of the service. The testing outfits and apparatus for the standardization of indicators, gages, and other instruments now at the New York navy yard should be kept at this school."

"Whenever an engineer officer has a plan for the investigation of any subject in practical engineering, chemistry, metallurgy, on propellers, lubrication, boiler deterioration, or any of the many other points directly connected with, or useful to, naval engineering, he would submit it to the chief of the bureau of steam engineering, through the regular channels, giving his ideas and the scope of the investigation as fully as may be necessary to a clear understanding. Should the bureau approve his plan, or think the matter worthy of experiment, the officer would then be detailed to the school, as soon as the exigencies of the service permit. In case of approval, no radical change in the applicant's proposed method of investigation should be made, as he should be given credit for his ideas and allowed to carry them out in his own way. Should any change in the method of the subject be deemed advisable, the applicant should be notified before the plan is approved. There is no use in ordering any one interested in a particular subject to investigate it in any radically different way from his own, for it deprives the experimenter of that personal interest without which there will be no success. Should the bureau or the director at any time wish to make original tests or experiments, engineer officers could be ordered as at present, if any are necessary in addition to the officers stationed at the school."

A course of instruction for the assistant engineers just after their promotion from naval cadets, and a museum "of engineering models, metals, instruments, and supplies," are also suggested as a useful com-

plement to the scheme of the experimental station. The founding of such a station would, at small expense, enable "the excellent work of Isherwood, Loring, Thurston, Emery, and other American naval engineers" to be carried on "systematically and intelligently."

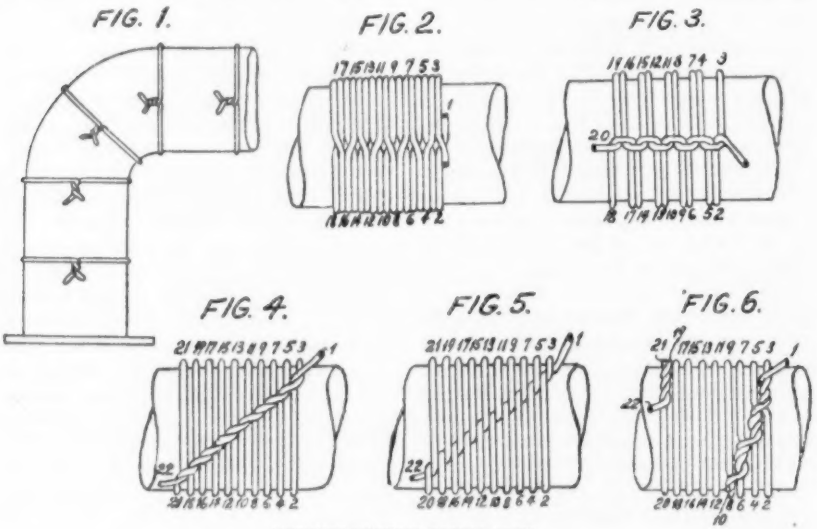
It is seldom that a paper of any sort is complimented by so hearty an approval and so lengthy a discussion as was bestowed upon this one. The approval of the scheme was not only well-nigh unanimous, but enthusiastic.

Tests of Wound Copper Pipes.

IN these tests, made at the Imperial Dockyard, Wilhelmshaven, Germany, and reported in the *Zeitschrift des Vereins Deutscher Ingenieure* by Chief Engineer Kohn non Jaski (translated for the *Journal of the American Society of Naval Engineers*), copper pipes having respectively an inside diameter of 7.87 and 11.81 in., and a thickness of 0.295 and 0.413 in., were used. According to the formula $t=\frac{pD}{5689}$, these pipes were suitable for a working pressure of 213 lbs. per square inch, and thus a factor of safety of at least ten was adopted.

The hydrostatic pressure in five of the tests was carried only far enough to destroy the wire rope used in winding the pipe. The rope was simply coiled around the pipes, which were made to order in Berlin by C. Heckmann. Twenty test pieces from strips cut from the ends, and in a direction at right angles to the axis, showed an average tensile strength of 31,106 lbs. per square inch and an elongation of 25.2 per cent. in a length of 7.87 in., and, after annealing a tensile strength of 30,537 lbs. and an elongation of 35 per cent. Cold bending and forge tests gave satisfactory results; the material of the pipes was of the best quality.

Copper wire ropes proved too ductile; and, notwithstanding the great weight and cost of these ropes, the sides of the pipe were not well supported, and considerable expansion resulted. As the result of conclusions derived from experiments with copper wire rope and with galvanized steel rope of lesser diameter, galvanized steel ropes 0.2952 in. in circumference were used for the 7.87-in. pipes and the 0.3937-in. pipes. "The various windings shown in Figs. 2 to 6 were used, and the pipes subjected to a hydrostatic pressure. As a matter of fact, the bights in the different windings were close together, as shown in



METHODS WINDING COPPER PIPES.

Fig. 2; in the other figures, they are shown separated, in order to make the method of winding clearer. The figures indicate the direction of winding. After the breaking of the first bight in Fig. 2, the adjacent parts of the same winding were held in place by the other rope, wound in the opposite direction. But, as soon as a bight of this second rope broke near the first place, all bights for a distance of 2.9 to 4.7 in. either side of it became loose."

In the winding shown in Fig. 3 eight adjacent bights broke at a pressure of 1877 lbs. per square inch, the rope being very unfavorably strained because of the knotting. After the first bight in the winding shown in Fig. 4 gave way, the adjacent ones loosened on the pipe, but again tightened as the pipe expanded. In the winding shown in Fig. 5 the bights next to the place of fracture became looser than in the last-named winding, but they also tightened again under the expansion of the pipe.

"In the winding shown in Fig. 6, the first bight broke at a pressure of 2418 lbs. per square inch, the adjacent bights remaining perfectly tight. After increasing the pressure to 2560 lbs., other bights broke, but all adjacent ones remained tight. Where the rope XX broke, the pipe expanded, and a number of other bights broke at pressures of 1422 and 1707 lbs., but all bights which were not broken remained tight around the pipe. In test 17, with the same kind of widening, being a parallel test to 8, the first bight broke at 2707 lbs. The pressure was then increased to 2958 lbs., when other bights broke. The behavior of the bights was the same as in the preceding test. Accordingly, the method of winding shown in Fig. 6 proved to be the most satisfactory, and from its behavior could be designated as thoroughly reliable for use on ship-board."

The following is the substance of rules adopted as a result of these tests, and promulgated to the German navy. (1) The maximum stretch to which any copper pipe may be subjected is fixed at 2844 lbs. per sq. in., and the strength due to winding must be eliminated from the calculation. The minimum thickness is fixed at 0.157 in. (2) Pipes must be either solid drawn, or made of sheet copper with double butt straps and riveted. All pipes above 4.72 in., and used for steam pressures of 100 lbs. and over, must be wound as indicated in Fig. 6, the table below giving the sizes of ropes required for pipes of different inside diameters.

Inside diameter of pipe. In.	Circumference of steel wire rope. In.
4.72 to 5.9	0.2952
6.10 to 7.87	0.3937
8.07 to 9.84	0.492
10.03 to 11.81	0.5906
12.00 to 13.77	0.6889
13.97 to 15.74	0.7874

(4) All main steam pipes of sizes indicated in the table must have flanges riveted on, not brazed.

Electrical Canal-Boat Towage.

IN a communication to *The Engineer* (London,) Mr. Geo. Cawley clearly exposes a principle which should govern attempts at applying mechanical power derived from any source to boat-haulage; and he also describes and illustrates an electric locomotive and a track by which the principle may be carried out. He maintains that the "ideal form of general electric haulage for canals should, in this mode of operation, be as nearly like horse haulage as possible; that is to say, the haulage should be effected through a towing line, as by this means we can increase the efficiency of haulage and insure minimum damage to the canal banks. When a fairly high speed is maintained by a screw tug-boat in the confined channel of a narrow canal, it is only done by a relatively great propelling power, and, unfortunately for the canal banks, the excess of power required by the boat in a narrow canal above that necessary for the same speed in open water is largely spent in promoting destruction. A considerable portion of this destruction is due to the action of the propeller and the consequent wash upon the banks. Any method of electric haulage which requires the use of a submerged propeller, therefore, does nothing to reduce this cause of commercial loss to a canal company, while it

is also unsuitable for dealing with shallow draught boats.

"The foregoing considerations support the contention that the ideal power haulage system for canals should be based on the towing-line principle; for, if energy equal in amount to that developed by the steam or electric motor driving a screw propeller were transmitted through a towing line from an electric locomotive travelling along the canal bank, the advantages gained over the submerged propeller system would be as follows: (1) reduction in percentage of wasted energy; (2) reduction of the wash, and consequent damage to the canal banks; (3) capability of applying haulage power to boats of even the smallest draught.

"Had the electric haulage plant unsuccessfully tried on the Erie canal been on the towing-line principle, the difficulties arising from the shallow draught of the boats would not have arisen. It should, however, be stated that, in order to make the towing-line haulage system of general application, it should fulfil the following conditions: (1) the haulage locomotive should not require a driver, and it should be controllable from the boat; (2) the up-and-down locomotive track should not seriously interfere with the present towing path as regards horse-haulage; (3) the locomotive should be able to pass along the whole length of the canal,—that is, through tunnels or under bridges, over public roads which cross the canal route, and along the steep slopes in the vicinity of some locks; (4) the general working economy of the system should be superior to the haulage now commonly used on canals."

The general character of the system of electric towage presented by Mr. Wheeler is that of two elevated-railway, single-rail tracks, each supported by brackets projecting from the sides of posts, and one far enough above the other to allow motors on one track to pass those on the other. The tow lines are attached to the bottoms of the motors and are attached to boats. They would be generally used in hauling in precisely the way in which they are now used in towing with horses or mules. An arrangement whereby the motor driving wheels are made to press upon the rails sufficiently to get the required traction seems adequate for this purpose, and the motors can be made light. As the track passes well above public highways, interference with traffic on the latter will not need consideration.

THE Committee of works of the Mersey docks and harbor board has decided upon some extensive alterations and improvements at the Foreign Animals Wharf, Birkenhead. In connection with the cold air stores there is to be a complete renovation on the Linde system of the refrigerating machinery, a large portion of which is of an antiquated description. An additional chill-room, to be kept at a uniform temperature of 33 deg. Fah., is to be constructed.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Technical Journals—See Introductory.

*1306. Transatlantic Steamships of 1856 to 1880. Ill. Samuel Ward Stanton (A quarter century's progress in ocean travel, from the Great Eastern to the first steel steamships). Eng Mag—Nov. 4000 w.

1319. The Evolution of the International Racing Yacht. Ill. J. B. W. (The series will trace in a brief way and with the aid of diagrams, the development of the racing yacht in the last ten years, and will show the evolution from American sloop and English cutter of the present accepted type). Sci Am—Sept. 14. Serial. 1st part. 1600 w.

1342.—$1.25. On the Necessity and Value of Scientific Research in Naval Engineering Matters as Related to the U. S. Navy, and the Necessity of an Engineer Training for the Younger Members of the Engineer Corps of the U. S. Navy. F. C. Bieg (Deals with the desirability of a government experimental station, and the aid which such a station would afford to marine engineering in the United States). Jour Am Soc Nav Eng—Aug. 13500 w.

1343.—$1.25. Experiments in Connection with Evaporation. Ill. D. B. Morison (One of the most exhaustive, practical and theoretical discussions of the subject that has yet appeared

We supply copies of these articles. See introductory.

in print). Jour Am Soc Nav Eng–Aug. 6500 w.

1344.—$1.25. Curves showing the Relation Between Equivalent Hollow and Solid Shafts. W. F. Durand (Defines equivalent shafts as those that will carry equal turning or bending moments with equal outer fibre stresses. States the advantages of hollow shafts as compared with solid ones, with formulæ for computing, and a diagram wherein, by curves, equivalent shafts are indicated). Jour Am Soc Nav Eng–Aug. 600 w.

1345.—$1.25. Test of Wound Copper Pipes. Ill. (A very important and interesting practical paper describing results of experiments with wound copper pipes, the winding being performed by different systems. Results tabulated). Jour Am Soc Nav Eng–Aug. 2400 w.

1346.—$1.25. Remarks on Steam Pipes. J. T. Milton. (A valuable contribution to the literature of this subject now undergoing thorough investigation, with a view to the attainment of greater safety under modern high pressures. Presents many points of interest). Jour Am Soc Nav Eng–Aug. 4200 w.

1350. The Ship Canal Illusion (A strong editorial against the policy of constructing a ship canal connecting the Great Lakes with the Atlantic). Sea–Sept. 12. 2200 w.

1377. Impregnable Armour Plate. From *N. Y. Sun* (Accounts of a government test, primarily a test of steel armor plate, but really a trial of the strength of the frames of modern war-ships, which it had been claimed could not withstand the shock caused by heavy projectiles against the armor covering them). Eng–Sept. 14. 900 w.

*1427. Fitting Machinery in Screw Steamers. Ill. (This first number indicates that the subject will receive a thorough, practical treatment). Eng, Lond–Sept. 16. Serial. 1st part. 1100 w.

*1428. Dredging Vessels for the Russian Imperial Government. Ill. (Description of the latest of five dredging vessels constructed for the Russian government). Eng, Lond–Sept. 6. 500 w.

*1449. The New Glasgow Docks. Ill. (Full description of the new tidal dock on the south side of Glasgow harbor, constitutes the first number). Engng–Sept. 6. Serial. 1st part. 2000 w.

*1453. Shipwrecks, British and Foreign (A review of Lloyds' record of shipwrecks, recently issued). Engng–Sept. 6. 900 w.

*1455. Water-Tube Boilers in the Navy (A series of communications criticising water-tube boilers for marine use, and claiming that they have not yet passed out of the experimental stage; exemplifying the argument by instancing the record of such a boiler during two voyages of the Wilson liner, Ohio, etc). Engng–Sept. 6. 5500 w.

†1471. Ship Lights. A. Ewbank (A mathematical analysis of the effect of changing position upon estimation of the danger distance by observation of lights at sea. An alleged rapid method of making such estimation). Ind Engng–Aug. 24. Serial. 1st part. 1800 w.

*1509. The Composite Screw Steam Tug "Sir Frederic." Ill. (Descriptive; also presents indicator diagrams. Steam 162 lbs. vacuum 26 in.; revolutions 124). Engng–Sept. 13. 1300 w.

*1511. The Torpedo-Boat Destroyer "Sokol" (Descriptive and critical. Shows how the use of new metals and appliances have made it possible to increase lightness and speed). Engng–Sept. 13. 1800 w.

*1547. Changing Propellers Afloat (Describes the removal of a broken propeller and replacing it by a new one on a steamship while afloat by emptying after ballast tanks and filling her fore peak with water, thus lifting her stern tube to the surface). Prac Eng–Sept. 13. 900 w.

1637. Resources of American Shipbuilders. Ill. (Will give descriptions of American ship yards and ship building firms. This number describes the establishment of the Craig Shipbuilding Co., Toledo, Ohio). Eng–Sept. 28. 700 w.

†1730. Our Need of Stringent Shipping Laws. Frank Rotherham (The establishment of fast transatlantic steamship lines under the American flag makes the call imperative. British laws cited as securing the protection and security felt in their vessels. Instances illustrating the necessity). N Am Rev–Oct. 1200 w.

*1835. A New Steam Lifeboat (Editorial. Performance of a new hydraulic propelled steam lifeboat. The belief is expressed that in this boat exists the type of the lifeboat of the future. This is the second boat of this type yet constructed, *Duke of Northumberland* being the first, and the description given of her hull, engines, and propelling apparatus applies equally to both boats; the latest differing only in being somewhat larger). Eng, Lond–Sept. 27. 1500 w.

*1836. Presidential Address of Mr. Durston before the Institute of Marine Engineers (Discusses water-tube boilers for naval use, gives reasons for their adoption in the British navy, naming examples of vessels fitted out with them. Also discusses the subject of leaky tubes, with a review of experiments performed to discover causes and remedies for leaking; touches upon the topics of bursting boiler tubes, proportions of boilers, draught systems and general requirements for training officers, etc). Eng, Lond–Sept. 27. 3300 w.

*1837. The Effect of Wind and Atmospheric Pressure on the Tides. W. H. Wheeler (Read before Section G of the British Asso. The author thinks the wind blowing at any particular port a much more reliable guide to height of tides than barometric pressure, and gives interesting facts in support of his view). Eng, Lond–Sept. 27. 2500 w.

*1854. Navy Boilers (Editorial review of Mr. Durston's address before the Institute of Marine Engineers. Containing also a spirited criticism of the action of the British Admiralty upon the subject of water tube boilers). Engng–Sept. 27. 1800 w.

1856. The Port Royal Dry Dock. Ill. (Detailed description of a new timber dock, comprising features different from the new Port Orchard timber dock, and from the Simpson timber docks). Eng Rec–Oct. 5. 1400 w.

MECHANICAL ENGINEERING

Progress in Steel Castings.

AT the last meeting of the American Society of Mechanical Engineers a paper was read by Mr. M. H. L. Gantt (*Practical Engineer*, which gave an outline of the history of the young art of making soft steel castings, and added some interesting information relating to its present status.

"The first soft steel castings, such as are used for gun carriages that are made in this country, and which were subjected to a ballistic test, were made in 1886 and 1887 by the Midvale Steel Company, who were the pioneers in this work. The ballistic test was considered severe at that time; but to-day the ordinary soft castings made by almost any one of a dozen of the best steel-casting companies would pass it successfully." Steel castings were, however, made in this country at an earlier date. In July, 1867, "the William Butcher Steelworks, now the Midvale Steel works, cast some crossing frogs for the Philadelphia Railroad of crucible steel. The molds were made of ground fire-brick, black-lead crucible pots ground fine, and fire-clay, and washed with a black-lead wash. The surfaces of these castings were very smooth, and the metal, which was practically tool-steel, was so well adapted for the purpose that some of the castings made in those early days are said to be still in use.

"This was before the use of silicon for solidifying steel was known, and the castings were very much honeycombed in all parts, except the wearing surface of the frogs, which was 'cast down.' The possibility of getting one face of a casting approximately solid admitted of the use of steel also for hammer dies, although their general sponginess was a great obstacle to their extensive adoption."

But it was not discovered until later that many of the imperfections in steel castings were directly caused by pouring the metal when not sufficiently hot. This finally becoming apparent, another step in advance was taken. It was in small castings that the imperfections were chiefly apparent, and there were and are difficulties in "getting uniformly hot metal in an open hearth furnace. The delay caused by a slow or difficult tap of the furnace, which is always liable to occur, is fatal to the production of the best castings. . . . Cold metal in the ladle is to day the cause of more complaint by purchasers, and expense to the manufacturer, than anything else in connection with the manufacture of steel castings.

"As long as castings were small, the molding mixture of ground brick, ground pots, and fire-clay was satisfactory; but, on large castings made with that facing, the surface was very imperfect, and the sand adhered to it with great tenacity. But little improvement in the method of molding was made for some time, and, while the quality of the steel was gradually improved, the appearance of the castings was decidedly against them, and but little progress was made in their introduction.

"The next step taken by the Midvale Company was to leave the ground pots out of the molding mixture, and to wash the mold with finely-ground clay fire-brick. This was a great step in advance, especially in heavy castings, and a marked improvement took place in their general appearance; but the mixture still clung so strongly to the casting that only comparatively simple shapes could be made with certainty. A mold made of such a mixture became almost as hard as fire-brick when dried, and offered so much resistance to the proper shrinking of castings that, when at all complicated in shape, they had so great a tendency to crack that their successful manufacture was almost impossible. The next step was to use a mixture of silica sand and flour. In small castings this gave pretty good results, as such a facing cleaned off the casting very readily, leaving a smooth surface much superior in

appearance to that left by the ground brick. The great difficulty in the way of the extended use of such a facing was the tendency of the flour to burn in drying, leaving the sand without a proper bond; and often the burnt mold was so friable as to be entirely useless. In the case of large castings it was almost impossible to dry thoroughly the whole mold without burning that portion nearest the fire, and for such work flour was necessarily abandoned." By this time the use of silicon for solidifying castings was coming into general use, and the only obstacle in the way of making good steel castings was the want of a suitable molding sand. This was ultimately found in a mixture the principal constituents of which were silica sand and molasses ground together.

The improvement in the appearance of castings caused by the use of sand that left a clean, smooth skin was the cause of their rapid adoption; and the year 1887, when the Midvale Steel Company made the first gun-carriage casting of steel, is approximately the date at which their rapid extension began.

Dealing next with theoretical explanations of some of the troubles traceable to the use of insufficiently-heated metal, Mr. Gantt concludes this part of the discussion with a very encouraging statement. "That shrinking holes and cracks do still occur in steel castings is well known, but the success that founders have had in casting complicated shapes within the last year or two has been surprising. The fact that a steel casting must cool at the bottom first, and then gradually upward in the mold, is being learned by designers; and shrinkage holes are becoming less frequent, for the founder at once fixes on the heaviest portion of his sink head, which is usually about 20 per cent. of the total weight of the casting, and which must remain fluid until the whole of the casting proper is solid."

As to designing forms for steel castings, the rule that,as far as possible, they should be of uniform thickness throughout holds with even greater force than for forms to be made of cast iron. By adherence to this rule castings of steel are now made 20 ft., long by 10 ft. wide. Such castings would have been thought impossible only a few years ago.

Experimental Study of Belt Lacing.

WE present in the form of an abstract the results of experiments which will go far toward settling the question of the best way of lacing belts,—experiments described in an article by Walter Flint, M. E., of Maine College, Orono, Me., in *American Machinist* (Sept. 5). The experiments were directed to the ascertaining of strength only, wear not being considered. It would be desirable to have these tests supplemented by tests in actual running under stresses approximating those used by Mr. Flint, because there is no warrant beyond mere inference for assuming that the results would be the same in both cases, or even that they would be relatively the same. Such supplementary tests, to be accepted as conclusive, ought also to be made on pulleys of large, medium, and small size, to determine effects of flexure upon the durability of the different lacings, and with tensions such as are considered proper in actual practice. The experimental method is the only one whereby the truth in this matter can be reached.

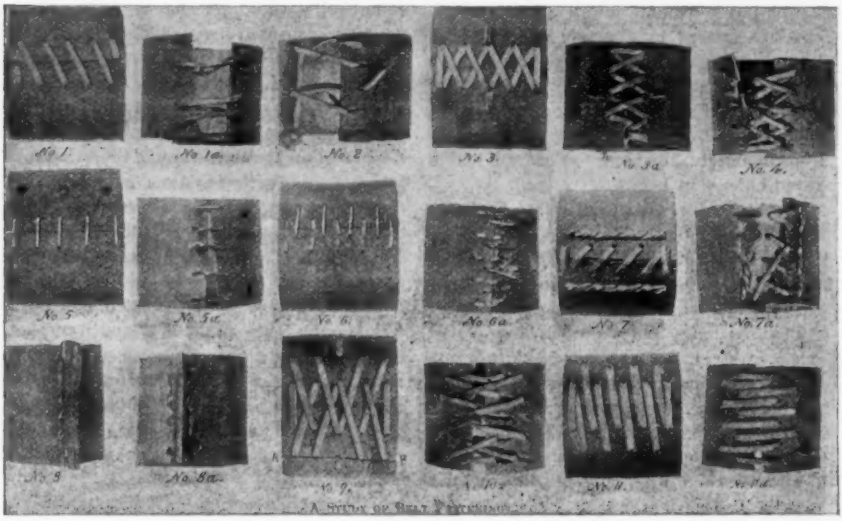
The tests were made with 4-in. beltings. "Five holes were punched ¾ in. from the end for a single row of holes, and for a double row of holes the second row was 1¾ in. from the end. The punched holes were $\frac{5}{16}$ in. diameter. These five holes removed $1\frac{5}{16}$ in. from the width of the belt. The belt being 4 in. wide, the net section is about 76 per cent. of solid belt, while, in the cases where the holes were cut with an awl, the net section is theoretically about the same as the solid belt.

"The apparatus for holding the specimens was so constructed that the belt was free to move as though it were on pulleys, thus equalizing the strain in that direction. It was then held in the testing machine by hooks which allowed it to stretch more on one side than on the other if it wanted to. This latter condition is not strictly true of a belt on pulleys, but, considering the very

short length of the samples, it was thought best to have it so in these tests.

"(Nos. 1 and 1*a*)—The form of this joint is plainly shown in cut No. 1, and No. 1*a* shows the break. The belt was not injured. The lace broke in the middle first, and then on the edge. The joint failed under a tension of 1150 lbs. Since the net section should hold about 2065 lbs., it is clear that more laces should be put in.

"(No. 2.)—This is the same form of joint as No. 1, except that the holes were made with an awl. It was not thought worth while to photograph this one before testing. It will be noticed that the lace cut the belt from the holes in various directions. The lace did not fail till after the belt failed on the lower side. The joint failed at 790 lbs., and the form of the



break shows that the failure was due to the form of holes rather than weakness of belt.

"(Nos. 3 and 3*a*)—Same number of holes and punched same as No. 1, but double laced, as shown in cut No. 3*a*, at *c*. The lace was not broken. Tension applied, 1460 lbs.

"(No. 4)—Exactly the same as No. 2, except that it was double laced as No. 3. Tension applied, 1335 lbs. It failed by the lace cutting through the belt. Shape of holes was cause of failure. The lace was not injured. These tests would seem to show that holes cut with an awl are far inferior to punched holes.

"(Nos. 5 and 5*a*)—This was a trial of one of the metallic fastenings. The fastenings being 1 in. long, the holes had to be made ½ in. from the end of belt. No. 5*a* shows the broken joint. Tension applied, 725 lbs. Two of the hooks broke, one straightened out, one pulled through the belt, and one remained sound, thus showing failure of both belt and fastenings.

"(Nos. 6 and 6*a*)—Same as No. 5, except that by staggering the holes four more hooks were put in. No. 6*a* shows the broken joint which failed under a tension of 1480 lbs. Both belt and fastenings failed.

"(Nos. 7 and 7*a*)—Cut No. 7 shows this form of joint. Holes punched. The break is shown in 7*a*, and took place at 1510 lbs. The lace failed in one place, while the belt failed generally.

"(Nos. 8 and 8*a*)—This is known as the "boot leg" lacing, and is a great favorite in Eastern Maine, because of its durability. Of course it cannot be used with a tightener or in many other places. No. 8*a* shows the break which occurred in the lace; the belt itself had started to tear in several places on the inside. Tension applied, 1310 lbs.

"(No. 9)—This is a double laced joint, with only one strand in each hole. Holes punched. The negative of the broken specimen was lost, but the break occurred along the line *A B*. The lace was not injured. As nearly as could be observed, the break was simultaneous along *A B*. Tension applied, 2015 lbs. The net section of belt should have held about 2065 lbs. This would seem to show that nothing further can be obtained when five $\frac{3}{16}$-in. holes are used, since the lace held more than the belt.

"(No. 10)—Same as No. 9, except that the holes were cut with an awl. It was thought, since No. 9 failed on account of too small a net section, that making holes with an awl might possibly help matters. The cut shows the result. The lace was not injured. Tension applied, 1590 lbs.

"(Nos. 11 and 11*a*)—No. 11 is peculiar, in that the holes are staggered, one strand in each hole, and strands not crossing on either side. There appears to be no reason why it should not hold as much as No. 9. The lace was evidently faulty, since the hole did not appear particularly strained. No. 11*a* shows the broken lace, on the lower side. Tension applied, 1835 lbs. This comes the nearest to No. 9 in strength."

Coal Gas as Motive Power for Self-Propelling Road Vehicles.

THE probable near removal of restrictions upon the use of self-propelled vehicles on English public roads leads the *Journal of Gas Lighting* to urge "the ingenious to apply themselves with all the ardor that opportunity affords to the production of such self-propelled vehicles as may appear likely to obtain, first of all, a share of the premium offered by the *Engineer*, and afterwards an even more remunerative need of public patronage."

As a motive power compressed gas offers marked advantages for this purpose. It has been applied with remarkable success at Dessau for propelling street cars on tramways, and the analogy of this use to that of moving vehicles on common roadways will be at once admitted. "Gas power is well to the front as a means of driving tramcars; and there is no apparent reason why it should not answer as well off as on the rails. . . . The electricians appear to be flattering themselves that the solution of the problem is in their hands; but the evidence in support of this supposition is extremely slight. Even for working tramcars, electricians can do nothing without the objectionable trolley wire, which is, of course, impossible for free road traffic. Their only aid to free carriage driving is the accumulator, which has never yet succeeded in justifying itself for this application, notwithstanding the tens of thousands of pounds that have been spent in experiments with this ponderous and inefficient means of propulsion. The most successful self-propelled road carriages yet made have been driven by steam or petroleum-spirit engines, especially the latter; and it is with the best of these that the adapters of gas motors to the new application will have to compete."

"It remains to be seen whether naphtha or compressed gas is preferable on all accounts as a portable source of energy. For compactness there is probably nothing to surpass petroleum spirit; and, if Mr. Maxim's judgment in the matter of driving his flying-machine is worth anything in this connection, it may be better to burn the spirit as a fuel for raising steam than to gasify it for use in an internal combustion engine. Naphtha and spirit, on the other hand, are dirty, and are not devoid of risk in handling or using. A cylinder of gas, on the contrary, is incapable of making a mess; and the risk of carrying and handling it is certainly less than that attaching to volatile mineral spirit. It must not be forgotten, moreover, that the noble animal, the horse, whose place between the shafts is to be taken by the engine carried in the body of the conveyance, is not free from little tricks of his own. The subject of risk, indeed, hardly enters into the discussion of the suitability of compressed gas for driving vehicles. A certain, or rather uncertain, amount of danger attaches to the use of every appanage of material civilization; and, unless this amount can be proved to be materially increased by any particular ap-

pliance,—which is not the case with compressed gas motor engines,—there is no need to regard it as affecting the issue." Inventors and designers will do well to look over the whole field of motors for light propulsion both on land and water. Compactness is one of the chief requisites of the road-vehicle motor; yet this must not be taken to mean that compactness over shadows other important qualities, which are in great measure the same as those belonging to all motors used to propel comparatively light vehicles or boats.

False Economies in Foundries.

MR. H. HANSEN read a paper before the late convention of the Western Foundrymen's Association (*The Iron Age*, Sept. 26) in which he maintained that the term economy poorly fits too many of the savings made in the foundry. In this paper and the discussion elicited by it several significant facts are made apparent. One of these is that, as the manufacture of foundry tools is becoming a trade in itself, and "the men engaged in it are bending every energy toward developing superior appliances for the foundry," it is, as a rule, a false economy for foundrymen to manufacture their own tools. Another false economy is in the use of makeshifts, although there may be exceptional jobs and conditions that may justify a resort to them. Cheap men and cheap iron were named as false economies. The cheap iron may be found "cheap to get out of the foundry," but it will be dear when it gets into the machine shop. "Cheap men make poor castings and have to make them over again."

Mr. John Pettigrew said: "It is only about 6 months ago that I first bought '*made*' chaplets. We were making our own chaplets, and we lost a great many castings from their not being properly made. After we had bought the first lot, for, I think, 60 cts. per one hundred chaplets, I commenced to figure up the cost of the chaplets we had been making and found it had been $2.50 per hundred, and they were not so good."

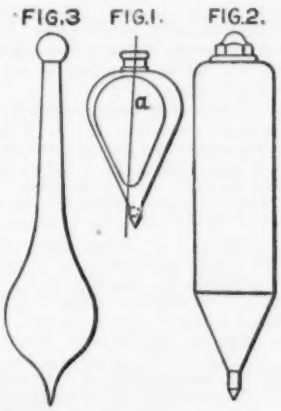
Mr. Hanna questioned whether anybody ever made anything by working nights and overtime. He believed that it is economy to run a plant at its full legitimate, capacity, but a false economy to attempt to exceed capacity. A cheap foundry foreman was named by another member as one of the false economies of foundry practice. In the office and counting room there appears to be also some defects. Mr. J. A. Brady criticised methods of purchasing. He said: "I have been connected with foundries where they did all their buying in the office. Perhaps some young man gets into the office, and he is put in the position of buyer. Somebody comes along with iron that is 50 cents a ton cheaper. He will buy it and ring it in on the foreman. Perhaps he will try to pass it off as another brand, as another iron. The same is true with coke. It has occurred in my experience that buyers would give me very inferior iron and coke and try to pass it off on me as good, when I knew, and they knew, that it was inferior. They were giving me those cheap things, and expected the same results as with good materials."

A Word About Plumb Bobs.

IN an article on erecting and starting steam engines, by "Spike" in *Machinery* (New York, Oct.), some useful hints regarding the plumb-line and plumb-bob are given. This implement, when well-made, ought to be classed among tools and instruments of accuracy; but "Spike" shows that, as ordinarily made and kept on sale in the hardware and tool stores, it is an instrument of inaccuracy. He says:

"The first plumb-bob that I used was the regulation hardware store arrangement familiar to all (see Fig. 1), and it got me into lots of trouble. It was brass, cast hollow, and filled with lead, and the brass was about $\frac{5}{16}$ in. thick on one side, or $\frac{1}{32}$ in. on the other. The lead, being heavier than the brass, brought the center of gravity to one side, or on a line *a* (Fig. 1), and the shape kept it well up; consequently the error was magnified considerably at the point. That plumb-bob met with an accident, or I probably should have never known how it was constructed or why its point would scribe a circle if it got to whirling. Then I made one like that shown in

Fig. 2, of a piece of steel 1¼ in. diameter by 4 in. long, which I considered all right, and used it for a long time, with lots of good chances to give it away, which I



finally did, and then made one like that shown in Fig. 3, which I thought couldn't be improved upon; but I am going to make one more, and it will be like the last named, only 9 in. long, while that shown in Fig. 3 is only 5 in. long. The new one will have a long, slim neck of ¼ in. diameter, and will be of tool steel instead of soft steel. For lines use braided silk, and in the long run you will find it much cheaper, and better satisfaction will offset the extra cost."

ON the announcement of the death of Mr. George W. N. Yost, inventor of the Yost typewriter *American Machinist* says: Mr. Yost was born in the western part of this state sixty-four years ago. His father was a farmer, but the boy early developed mechanical tastes, and found employment in the shops then building the Acme mower and reaper. He suggested various improvements and secured an interest in their manufacture. Later his inventive abilities produced the typewriter. From this he is said to have realized a fortune, which he lost in various speculations. He later organized a typewriter trust and accumulated a second fortune, but is said to have died a comparatively poor man.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Technical Journals—See Introductory.

The Machine Shop.

*1307. The Prevailing Scarcity of Skilled Labor. A. E. Outerbridge, Jr. (Showing that the development of industries due to new inventions has enormously increased the demand for skilled labor). Eng Mag-Nov. 4000 w.

*1318. Core Making. Ill. Joseph Horner (Subject practically treated with illustrations of a variety of cores for special purposes). Mech Wld-Sept. 6. Serial. 1st part. 1900 w.

1325. Some Good Steel Castings. Ill. Gus. C. Henning (Describes steel castings of large size which show a great advance in the state of the art as compared with castings made only a few years ago). Am Mach-Sept. 12. 700 w.

1327. Architect's Machine Design (A criticism of design of a machine, made by an architect of reputation, and general editorial remarks on the subject of machine design). Am Mach-Sept. 12. 700 w.

1428. Ring Oiling Device for Bearings. Ill. M. A. Chine (Describes a ring oiling device for bearings of shafting which appears to have great merit, and discusses, practically, ring and other oiling devices). Am Mach-Sept. 12. 2000 w.

1408. Hardening Steel. A Knowledge of the Process Which It Undergoes a Great Aid in Tempering (Chiefly a practical discussion, but touches somewhat upon the theory of hardening and tempering). Bos Jour of Com-Sept. 14. 1400 w.

1422. Contraction vs. Strength of Cast Iron. Thomas D. West (The object of this paper is to prove that the same element that can cause any form or size of test bar to be unreliable as a record of strength, also destroys its value for recording the contraction of iron). Ir Tr Rev-Sept. 12. 2000 w.

1430. Ball Turning Device. Ill. C. K. (Device for performing this operation in a common engine lathe). Age of St-Sept. 14. 400 w.

1477. Tempering Scientifically. A. A. Simonds (Results of 18 months experiments aided by a thermo-electrical pyrometer. An important article). Am Mach-Sept. 19. 1000 w.

1478. Belts and Belt Lacings. Tecumseh Swift (An examination of the article "An Experimental Study of Belt-lacing," by Walter E. Flint. Analysis of results). Am Mach-Sept. 19. 1100 w.

1479. Some Reasons Why Bearings Heat. Peter H. Bullock (Personal observations and conclusions). Am Mach-Sept. 19. 800 w.

1575. An Experimental Study of Belt Lacing. Ill. Walter Flint (Results of practical experiments on eleven different forms of belt

We supply copies of these articles. See Introductory.

lacing. A valuable article). Am Mach-Sept. 5. 900 w.

1578. Grinding Reamers and Milling Machine Cutters. Tecumseh Swift (Practical details). Am Mach-Sept. 5. 900 w.

1579. Some Points About Experimental and Special Work (Conditions on Which W. D. Forbes & Co. take and turn out work). Am Mach-Sept. 5. 800 w.

1601. False Economy in Foundry Equipment. H. Hausen (Read at the Western Foundrymen's Asso. An eminently practical paper in which it is held that "economy" is a misnomer for many of the savings made in the foundry. Discussion). Ir Age-Sept. 26. 3500 w.

1668. The Art of Callipering—Hardening and Tempering of Steel (A practical treatment of these subjects). Bos Jour of Com-Sept 28. 700 w.

1756. Bicycle Tools. Ill. Hugh Dolnar (Proposes to give accurate information as to tools and methods in use in bicycle shops. The first number treats of rim-gluing tools and rim-shaping). Am Mach-Oct. 3. Serial. 1st part. 2500 w.

1757. Spirals on the Milling Machine.—Notching and Hobbing Worm Wheels. Ill. A. H. Cleaves (An explanation of the application of formulæ printed in tables accompanying milling machines for the benefit of ordinary workmen and foremen). Am Mach-Oct. 3. 1700 w.

1773. The Teeth of Mills. Ill. Winthrop Ingersoll (Takes the ground that the problem of cheap mill grinding has not yet been fully met by anything in common use, and generally discusses the subject of the construction of milling machines, milling cutters, arrangement of teeth, etc). Mach-Oct. 2700 w.

1774. On the Transmission of Power by Ropes. Ill. John H. Cooper (Presents, in a condensed form, a profusion of leading facts and data which have been obtained by experience with, and discussion of this method of power transmission) Mach-Oct. 2200 w.

1777. Machine Builders Records. Henry Hess (Presents a new plan for keeping simple records that do not require rewriting with every change of design). Mach-Oct. 1200 w.

1778. Strength and Proportions of Gear Wheels. Ill. J. L. Klindworth (Description of method for designing teeth, with formulæ derived from F. Reuleaux). Mach-Oct. 2000 w.

Steam Engineering.

1409. Getting Rid of Scale (Deals with methods of prevention as well as those for removing scale, and points out a danger in the contraction method of removal unless the latter be applied with great skill and care). Bos Jour Com-Sept. 14. 1500 w.

1438. Piston Valves. Northeastern Railway of England. Ill. (Description also analyzes the cards taken from locomotives using these valves, with tables of the valve motions, including lead, opening, cut-off, release, angle of release, etc., for both forward and backward gear). Ry Rev-Sept. 14. 2000 w.

1577. Crank Shaft Stresses on the Central Valve Engine. W. H. Booth (Comparison between single and double acting engines). Am Mach-Sept. 5. 2700 w.

1604. The Design and Construction of Safety Valves for Steam Boilers. Ill. Edward W. Barber (Classifies and analyzes the action of the different types of safety valves; discusses proper and improper methods of fitting them to boilers, etc., favors the dead-weight type). Safety V-Sept. 15. 2700 w.

1605. A Method of Proportioning Cylinders for Compound Engines. E. C. Knapp (A method keeping in view that the load should be equally divided between the cylinders throughout the entire range of load, and that the range of expansion and temperature should be economical). Safety V-Sept. 15. 1100 w.

1606. Clearance in Steam Engine Cylinders (Editorial. Calls attention to the importance recently attached to clearance, and a general discussion of its effects). Safety V-Sept. 15. 1600 w.

1612. Vacuum; and How It Is Produced. Arthur Goodwin (Treats of the kind and degree of partial vacuum produced in condensation of steam, its measurement, and other practical and theoretical points connected with the subject). Mas St Fit-Sept. 1500 w.

*1657. Steam Locomotion for Passenger Traffic on Common Roads. Ill. William Fletcher (An exhaustive series of articles, well illustrated and with copious references, treating of steam locomotives intended for the conveyance of passengers and light goods at fairly high speeds, on common roads). Eng, Lond-Sept. 20. Serial. 1st part. 3000 w.

*1678. Summary of Twenty-one Steam Boiler Experiments. Bryan Donkin (A very able paper. The experiments made with vertical tubular, Lancashire, locomotive, water-tube, Cornish, elephant, cross tube fire engine and Cornish multitubular boilers, with tables of dimensions and data determined and results in fuel consumption, evaporation, etc., in tabulated form, and also graphically represented. Is a valuable contribution to the literature of steam engineering). Engng-Sept 20. 1800 w.

*1702. Boiler Furnaces: Their Construction and Renewal. Ill. A. V. Coster (A practical discussion of boiler furnaces considered as the most important factor in steam generation, and with a view to the attainment of greater durability). Ind & Ir-Sept. 20. 3000 w.

Miscellany.

1324. A Foundry Sketch—Low Priced Work. Ill. (Describes a variety of low-priced foundry work, turned out from western foundries, with practical remarks upon systems and processes whereby those results are reached. An instructive article). Am Mech-Sept. 12. 2300 w.

*1340. Coal Gas as a Locomotive Power (Editorial sustaining the view that compressed gas used in a manner analogous to that employed on tram cars at Dessau is more feasible for self-propelling road carriages than electricity). Jour Gas Lgt-Sept. 3. 1400 w.

1444. Gas as a Source of Power (A Comparison of its possibilities with electricity as a means of power transmission). Pro Age-Sept. 16. 800 w.

1456. Blast Furnace Gas.—Its Use as a Motive Power Practical and Economical (Experiments in England and France discussed. Mechanical difficulties). Tradesman-Sept. 15. 2200 w.

*1485 A New Departure in Dock Pumping. Ill. (Description of a Tangye gas-engine as applied to dock pumping). Eng, Lond-Sept. 13. 900 w.

*1512. Triple-Expansion Engine with Corliss Valve Gear (Illustrated description of a stationary engine built for a South African firm by Messrs. Fraser and Chalmers, of Chicago). Engng-Sept. 13. 1500 w.

1550. Some Difficulties in Manufacturing. Clarence E. Bement (Read before the Mich. Eng. Soc. Discusses power tranmission, shafts, and counter-shafts, forging, foundry work, making additions to plant, repairs, management of men, etc). Ir Age-Sept. 19. 3000 w.

1564. Kerosene Motors. J. H. Killey (Their method of action as applied to vehicles, &c). Can Eng-Sept. 1300 w.

1576. Molding Pump Plungers Without Anchors. Ill. J. Weyhenmeyer (The most approved method). Am Mach-Sept. 5. 1000 w.

1594. Electric Power Pumps for Water Works. John M. Goodell (A comparison of pumping by gas engines with pumping by electric power; description of two electric pumping plants; small, high service districts considered a promising field for the use of electricity for waterworks pumping). Eng News-Sept. 26. 2500 w.

1602. An Example of Cost Sheets for Foundries. A. Sorge, Jr. (Exemplification of blanks for cost sheets and system of preparing them, framed on a logical basis and designed to secure accuracy. Discussion). Ir Age-Sept. 26. 5000 w.

1603. Reduction and the Effect of Diameters on Bars in Rolls. William Hirst (Principles which should govern design of rolls for different sections; knowledge of best form of passes essential. Rolls cannot be laid out from rules on account of the continually varying condition of the metal acted upon. A useful and instructive article). Ir Age-Sept. 26. 3500 w.

*1608. Coach Makers' Machinery. Ill. (Description of machinery and operations in modern carriage building, in the extensive works of Studebaker Bro's. Mfg. Co., South Bend, Ind). Mach, Lond-Sept. 15. 1000 w.

*1615. The DeKalb Electrical Pumping Plant. Ill. Daniel W. Mead (Full description with details; tabulated results; with lengthy discussion by members). Jour Asso Eng Soc-Aug. 9500 w.

1619. Compression in Locomotive Cylinders (Effect of compression on economy. Illustrated by three diagrams). R R Gaz-Sept. 27. 1400 w.

*1661. Locomotive Steam Crane. Ill. (A crane perched on a locomotive boiler). Eng, Lond-Sept. 20. 250 w.

*1679. Jointless Felloes (Describes and illustrates the processes of making steel bicycle rims at a great Birmingham establishment). Engng-Sept. 20. 2400 w.

1761. A Horseless Carriage of 1827. Ill. (In connection with the present effort toward constructing practicable self-propelling vehicles for common roads, this article, describing one of the earliest attempts at producing such a vehicle, will be read with interest). Sci Am-Oct. 5. 1400 w.

*1768. An Example of Wheel Construction. E. S. Cobb (Describes and illustrates a fly-wheel for a 500 H. P. engine designed by E. S. Cobb, of San Francisco, in which all the strains are tensile). Am Eng & R R Jour-Oct. 600 w.

1776. Directing and Starting Engines. Ill. "Spike" (A practical, useful and instructive paper, especially for young mechanical engineers. Gives full and plain directions for this kind of work). Mach-Oct. 2500 w.

1779. Machine Shop Arithmetic. W. L. Cheney (A series of practical articles clearly explaining the portions of mathematics which will be useful to the men in the shop and engine room). Mach-Oct. 2200 w.

1802. A Gas Engine that is Expected to Revolutionize the World's Power (An interview with Mr. Geo. Westinghouse, Jr., on new inventions, especially in regard to his opinion of gas engines). Mfrs' Rec-Oct 4. 3000 w.

*1817. Rotary Bolting Machines. Ill. Kernal Wheatley (Historical and descriptive). Am Miller-Oct. 1. 1500 w.

*1819. Mill Machinery and Methods. J. F. Newby (A paper read at the Penn. Millers' State Asso. A retrospection and discussion of the prevailing method of gradual reduction by rollers, with remarks upon handling and storing wheat, bolting, and machinery and appliances used in modern milling). Am Miller-Oct. 1. 1600 w.

1827. How to Overhaul a Gas Engine. Ill. J. W. Seers (Practical and plain directions for the care of gas-engines, and their maintenance in good running order). Am Gas Lgt Jour-Oct. 7. 1600 w.

*1834. The Soho Foundry. Ill. (Description of a famous establishment. The first number gives a history of the works since the time of their ownership by Boulton and Watt, and describes some of the tools, with excellent line engravings). Eng, Lond-Sept. 27. Serial. 1st part. 3800 w.

1848. The Strength of Metals at High Temperatures (Investigations of Le Chatelier. Important as relating to safety of copper and its alloys in engine and boiler mechanism under modern high steam pressures). Ry Rev-Oct. 5. 900 w.

1879. High Silica Fire Brick. Charles Terry (Stating the impossibility of producing a single brand of fire brick which shall give superior results in every class of furnace work. The most reliable index of their applicability is found in their chemical composition). Ir Age-Oct. 10. 1300 w.

MINING & METALLURGY

Legislation Against Mining Stock Brokers.

IN order to avert the possible evil effects of the practice of mining-stock brokers in dealing in shares on their own account, while buying and selling for others at the same time, the legislature of New Zealand is considering a bill conta ning a clause of which the following is the first paragraph:

"From and after the commencement of this act no sharebroker shall, on his own account, or on account of his wife or of any member of his family, or any clerk or servant in his employ, in any way, directly or indirectly, buy, sell, deal in, or become the holder of any shares or stock in any mining company registered or incorporated under the principal act or the companies act of 1882."

This remarkable clause has already passed the house, and will probably pass the upper chamber. *The Australian Mining Standard* (Aug. 24) thus comments upon it in an editorial: "It is an unfortunate thing that gambling should have associated itself so closely with mining. But there are certain features about the industry which lend themselves to speculation; and, so long as humanity is human, and shares are available, the game of speculation will be played. It may be *infra dig.* for brokers themselves to follow the example of their clients, the public, and operate on shares; just as it is unfortunate that the public should largely view mining as a medium for a gamble. And it may be that the practices of giving a fictitious value to property tend to mislead and destroy confidence. All mining countries are liable to 'booms,' the period when speculation is most rampant, and when legitimate industry is most handicapped. The liability, while it is to be deplored, will certainly not be removed by any such gross infringement of private rights as the legislature of New Zealand now seeks to impose. Brokers who job are simply members of the public, and if, for the betterment of their own fortunes, they apply the methods adopted by the public generally, however immoral, injurious, or objectionable those methods may be, they must not be specially censured; nor must their liberties be unfairly restricted in the manner proposed. It is bad enough to seek to deter the man himself; but to say that neither his wife, nor his sister, nor his cousin, nor his aunt, 'shall, directly or indirectly, buy, sell, or deal in, or become holder of any shares or stock' in mining companies, is the height of legislative absurdity." The editor concludes with the observation that "the evil they are grappling with may very well be left to work its own cure. Trouble may result from the operation in the meantime, but we are sure it would be insignificant compared with the disadvantages which must follow upon the insertion of the new clause in the Mining Companies Act Amendment Bill."

Use of Steel Girders in Mines.

REMOTE from the considerations of strength and life of steel, as compared with wood, for underground reinforcement, come those of availability and adaptability. In new camps timber is often plenty, but it requires very few years of continued mining to exhaust the neighboring supply. Fortunately the low price of structural steel makes it available as a competitor with timber for many uses—notably as a substitute for mine timbers. *The Colliery Guardian* (Sept. 20), in abstracting from a paper by Mr. E. Thompson read before the Federal Institute of Mining Engineers, says on this subject: "As an instance of the working conditions to be met with in a mine, it may be mentioned that the weight to be supported is not only unknown, but practically irresistible, and the strain is further complicated by pressures both from the top and the sides. Instead of being regular and uniform, the load is varied, and in cases increases with sudden and tremendous force. . . . It

may be mentioned that, in the mine where Bessemer steel girders were placed here and there among the timber bars, the latter have been broken, while the girders remained uninjured. A bent girder, of course, may be reset. The sections of girders in general use in main roads are as follows:

Depth of Girder.	Width of Flange.	Thickness of Web.	Weight per foot.	Estimated safe dead load, distributed over 8 ft. span.	Length of bars recommended for given weight per foot.
in.	in.	in.	lbs.	tons.	feet.
5	4	3/8	16 3/8	7	6 to 8
5	4	1/2	22	9	8 to 10
6	4 1/2	1/2	24	12	10 to 14

"At the present time, estimating the girders at £5 per ton, these sections cost respectively 9d. 1s. and 1s. 1d. per ft. Comparing these prices with best larch timber, the cost of girders is very little in excess of timber, and, if the cost of cutting and trimming the timber be included, with an allowance for waste, steel girders will probably be found to cost less per foot, and in addition prove much stronger. . . . Girders compare favorably with timber, as they give an additional 4 or 5 in. in the height of a road; they possess greater durability where exposed to moist air, which, in some mines, destroys the timber in a few weeks; and they are equally suited to pit bottoms, main roads, and return ways. Girders intended for use in very wet places may be tarred at a slight cost. They can be drawn and reset many times, where timber would not be worth the cost of recovery. In the event of fire, timber is not only destroyed, but helps to spread its effects, while girders remain intact, and the road in good order. The blocking of the roads caused by floating timber is also avoided, should the mine be flooded with water." The article treats of fastening devices, etc., and ends with the discussion of the paper, bringing out corroborative statements, as well as the fact that steel and iron posts and props were successfully employed in some coal collieries.

The Iron Industry in Germany and England.

AFTER considerable investigation of the condition of the German iron works, the British Iron Trade Association have prepared a report, advance items of which have appeared in the London *Times*, according to the English correspondent of the *American Manufacturer* (Sept. 20). The tenor of the report is liable to disturb the self-complacent manner in which an Englishman regards everything British. The deputation which visited the continental works "emphasize the superior character of the machinery and labor-saving appliances which are to be found at some of the Belgian and German works, showing a remarkable advance in those countries compared with even the best appointed works in England. The deputation are not now surprised at the rapid growth of the Belgian and German iron and steel exports."

There is not as much difference in wages as has been supposed, those of Belgium being even slightly higher than in England, showing that the growing German trade is not due to low wages.

"We know that ever since the introduction of the basic process the Germans have been quick to adopt the best machinery for steel making. While English manufacturers have paused—over-awed by the heavy cost which would be involved by laying down new plant,—the Germans have steadily gone in for steel making, and so have become formidable competitors in the steel trade. Moreover, the foreigners, who have closely studied the English systems of iron and steel manufacture, have at every point introduced some new feature of more or less value, directly tending to economize the manufacture. Further, in the matter of technical education, the Germans are ahead of us. At Berlin they built an enormous technical school out of a portion of the Franco-German war indemnity. That school has sent out chemists all over the civilized world, and some of them are to be found in the metallurgical laboratories at English works." However, this is not the only cause. "Many years ago Professor Willis

said: 'Englishmen make the best machines, whilst Germans describe them.' In other words, if you then wanted a good machine, you must buy it in England, and, if you wanted a description of it, you could read it only in German. This technical and scientific literature to which Prof. Willis referred has undoubtedly been the foundation on which Germany has built her manufacturing position as on a solid rock. By its means, and assisted by a thorough educational system, and supplemented by specific technical instruction such as we have as yet but imperfectly adopted, owners of works in Germany, as well as their foremen and workmen, commence their duties in the spirit of students rather than as prejudiced inheritors of old methods and ideas."

Though this is rather an extreme view of the case, the fact remains that the foreign English market is being gradually displaced by the continental products, especially such as are used in engineering work.

Comparative Effect of Explosives.

AN important feature of all modern investigation is the tendency to reduce all results to figures and to keep fixed records in such a way that results may be compared. This we see strikingly brought out in a series of experiments to determine the effect of certain explosives in deforming a lead cylinder, by Bergassessor Wickhaus. These results were communicated to *Glückauf* and republished in *The Colliery Guardian* (Sept. 20). The experiments were made on the assumption that the extension of the cavity in the lead block measured the explosive force.

The nearly cylindrical lead blocks used in the schalke (Westphalia) tests were prepared as shown by Fig. 1, having a height of 24 cm. and a diameter of 14 cm., a slightly conical form having been adopted for facilitating the casting of the block. The cylindrical hole 25 mm. in diameter and 145 mm. in depth is increased above for receiving the cover to a diameter of 60 mm. The lead block was wedged tightly into a strong wrought-iron frame, and the volume of the central cavity measured before and after explosion by water from graduated tubes. Ten-gram charges were employed, exploded by 2-

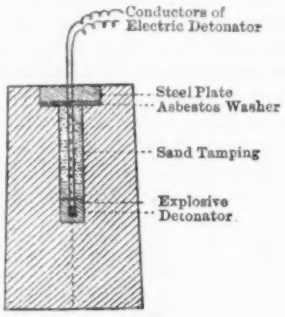


FIG. 1.

gram mercury fulminate detonators. "The analysis of the explosives tested are given as follows by various authorities. According to the president of the Berlin Mining Laboratory, gelatine-dynamite contains 64.5 per cent. of gelatinized nitro-glycerine, 26 per cent. of nitrate of potash, and 9.5 per cent. of ground wood, while the carbonite contained 25 per cent. of trinitro-glycerine. Firedamp dynamite contains 52.9 per cent. of trinitro-glycerine, 32.7 per cent. Epsom salts, and 14.4 per cent. fossil meal. Progressite: 92 per cent. ammonia nitrate, 6 per cent of aniline hydrochlorate, and 2 per cent. of ammonia sulphate. Westphalite consists of 94 per cent. of ammonia nitrate, 5.4 per cent of resin, 0.4 per cent. of ammonia sulphate, and 0.1 per cent. of each of sal-ammoniac and smut. Dahmenite: 93.3 per cent. of ammonia nitrate, 4.8 per cent. naphthaline, 1.6 per cent. of potash chlorid, 0.1 per cent. of sal-ammoniac, and 0.2 per cent of ammonia sulphate. Roburite: 17.8 per cent. of dinitro-benzol, 79.2 per cent. ammonia nitrate, 0.3 per cent. sal-ammoniac and ammonia sulphate, remainder moisture." It was found that the more uniform explosives gave the highest values.

"For showing the nature of their action, Fig. 2 gives a representation of the widening out of the cavity in the lead block effected by ten-gram charges of the explosives. The lines made by roburite,

dahmenite, and progressite, being very similar, were left out.

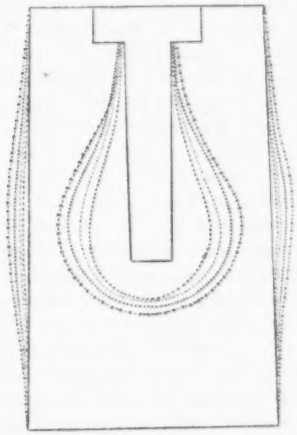

= Original form.
= Extension with a charge of 10 gr. (⅓ oz.) of Carbonite.
= Ditto Firedamp dynamite
= Ditto Westphalite.
= Ditto Gelatine-Dynamite

FIG. 2.

"As the resistance to distension becomes less, the less the thickness of the leaden sides. Experiments to determine the quantity and volume necessary to produce the same effect were performed. The table below gives in a summary the results of these experiments, showing the relative values of these high explosives."

Explosive.	A.	B.	C	D.
Gelatine-dynamite	10	1.000	1.00	1 000
Carbonite	21½	0 465	0.73	0.339
Firedamp dynamite	17	0 588	0.95	0.559
Progressite	17	0.588	0.60	0.353
Westphalite	14	0.714	0.55	0.393
Dahmenite A	13	0.770	0.53	0 408
Roburite	12	0 883	0.61	0.509

A.—Quantity (in grams) of explosive required to produce the same increase in space.

B.—Comparative explosive action calculated from A.

C. –Comparative weights of the same bulk.

D.—Explosive power of the same bulk.

The safety explosives—firedamp dynamite and roburite—are used almost exclusively in 23-mm. or 25-mm. cartridges, while the lower explosives are generally put up in 30-mm. to 40-mm. cartridges. The charge is thus distributed over a greater area, avoiding the shattering effect, which is specially undesirable in coal mining or blasting stone. The article, as originally contributed, contains full details of the experiments.

The Place of Tungsten in the Industries.

UNDER the above title Mr. F. Cramer contributes some facts of commercial interest in *The Iron Age* (Sept. 12). The properties which render tungsten of importance are its hardness and the property of imparting hardness to its alloys, and its high specific gravity. The largest quantity is used in alloying with steel, to which it imparts such natural hardness that no tempering is required when used for machine tools,—*i. e.*, it is "self-hardening." Speaking of the uses to which tungsten is put, the writer says: "The hardness of tungsten recommends it directly for use in cutting tools. In these it is the chief aim to have a hard resisting tool, with a certain degree of toughness to withstand shocks. This resistance it receives from an addition of manganese, and perhaps also of nickel. This kind of steel is not suitable for extremely hard work exposed to severe shocks, nor is any other steel. But in the manufacture of knives, surgical apparatus, and especially razors, tungsten could be employed to a great advantage. It is well to remember in this connection that an addition of carbon gives the steel a certain amount of hardness; so does tungsten. . . . . Whether tempered or untempered, the addition of tungsten to razor steel must result in a decided gain over carbon steel." For use in armor plates and projectiles "the objection has been raised that tungsten steel is too brittle for the purpose. This objection would be a very strong one, if the whole shell or plate were made of the same material throughout, although an addition of manganese could be employed to counteract this effect of tungsten. But, just as Harvey plates are given a coating of carburized and tempered steel so in tungsten plates only the surface

should contain tungsten. This is effected in a recent patent by Chase & Gouth, where molten steel is poured on a bed or mould covered with powdered tungsten, when the fluid steel melts and alloys with the tungsten." The author inclines to the belief that small quantities of tungsten added to structural steel will increase the elastic limit. "Howe's book on the metallurgy of steel contains the result of a number of experiments on tungsten steel, as furnished by Holtzer at the Paris exposition of 1887, and we take from them the following figures:

STEEL.	Tensile Strength.	Elastic Limit.	Elongation.
Naturally hard....	77,941	41,672	23.5
" " ...	93,071	47,514	17.0

.... A slight gain in the elastic limit over the steels now in use would amount to such a large saving in our modern gigantic structures that the game surely seems worth the candle." Tungsten could be added to aluminum to make it harder, in preference to copper, which has a tendency toward galvanic action in waters containing alkalies or acids.

"In all probability the hardness and resistance against abrasion of gold, silver, platinum, copper, etc., could be increased considerably, and silver and gold coins would make a splendid field for such tungsten alloys."

Among the suggested uses are steel springs, pianoforte wire, an abrasive in place of emery, rifle and other bullets, steel to increase magnetism, alloys and bronzes, and various chemical forms. The red oxid is harder than the metal, and may find its use as an abrasive. "The statement of Howe that 'steel may contain much larger proportions of tungsten than of carbon without losing its property of being forged,' seems to us perfectly correct. In any one of the twelve to fifteen mills in the United States where tungsten steel is made, one may any day see the product, generally containing from 5 to 6 per cent. of tungsten, forged, that being, in fact, the only way to reduce the ingots to bars."

Three Colorado Mine Tunnels.

ABOUT the forks of Clear creek cluster some of the richest gold mines in Colorado. The Colorado gold deposits are of unknown extent, and of such a reliable character that permanent works may be erected with the assurance that there is plenty of ore to work on. It is strange that the deposits have been almost ignored by English and continental capital in its craze over South African mines of less merit. A correspondent to *The Mining Journal* (Sept. 14) writes concerning the Clear creek tunnel enterprises: "These mines are operated at very considerable expense for pumping water, hoisting ore, and hauling such ore down to the railway tracks; and, in consequence of such excessive cost, the working of some of them has been temporarily abandoned, as there is no margin of profit left, notwithstanding the existence of large bodies of ore. In practically every case the deepest workings revealed the continuance of ore in undiminished quantity, and of much the same quality." To drain this district and to take out the ore by the assistance of gravity, three tunnel enterprises are in operation.

"The first of these is the Newhouse tunnel [described in THE ENGINEERING MAGAZINE for October.—ED.], being constructed by British capital. It enters the mountain a short distance below Idaho Springs. Its total length will be nearly 4 miles, running under Seaton mountain, Russell gulch, and Quartz hill, and will take several years to complete. It is expected to cut over three hundred known veins, exclusive of 'blind' veins,—that is, veins not known on the surface, and which will belong to the tunnel. It is 12 ft. wide by 12 ft. high, is already in ½ mile, and is being rapidly pushed by means of double shifts of men and Leyner air drills operated by powerful compressors.

"The second enterprise, the United States tunnel, is as yet only at its commencement, and, it is said, will be constructed by French and Dutch capital. It starts in about ½ mile above Idaho Springs, about 1½ miles west of Newhouse tunnel. It is proposed to run it about 3½ miles under Belle Vue mountain, the head

of Virginia cañon, Russell gulch, Quartz hill, and Gunnell hill, but as yet it is in but between 200 and 300 ft. by hand work, and air compressors have not, so far, been put up for the operation of air-drills.

"The third enterprise is the Philadelphia tunnel being constructed by Philadelphia capitalists, primarily to tap their own mining properties. It starts on Fall river (a tributary of Clear creek) about 4 miles above Idaho Springs. It is in about 2700 ft., and another 1000 ft. has been contracted for, 3000 ft. being required to crosscut their own property. It will be further continued to a total length of 2½ miles to tap the Nevadaville gold belt at its terminus, being about 1000 ft. below the surface. It is about 8 ft. by 9 ft. in size, and is expected to cost altogether about £100,000.

"Briefly stated, these three tunnels will undermine, at an average depth of from 1000 to 2000 ft., a mountain chain or group 4 miles in diameter, traversed by an extraordinary number of parallel true-fissure gold- and silver-bearing veins, the richness of many of which has been satisfactorily proved, while the existence and richness of the others is fairly assumed. . . . It is self-evident that the next few years will see wonderful mining development in that special locality, and a very marked increase in the gold product of Gilpin and Clear creek counties (both of them very small counties), which, under present conditions, is about £1,000,000 sterling per annum."

Open-Pit Mining.

MR. F. W. DENTON read a paper before the Lake Superior Mining Institute with the above title, having special reference to the Mesabi range. As these Minnesota iron ore deposits are practically closing all the small mines of our northern States, it becomes a matter of interest to know how they are able to produce ore thus economically. The author states that "thus far two general methods of open-pit work have been adopted: one is to strip a comparatively large area, and then, after having loosened the ore by blasting, to remove it by means of steam shovels, railway cars, and locomotives. The other method is known as the 'milling' system, or better, perhaps, as the 'stripping' milling system, and as a combination of surface and underground workings. The ore is stripped of its surface covering, and then blasted into raises which connect with drifts established 50 or 60 ft. below the top of the ore. From the raises the ore is loaded into cars, trammed to a shaft, and hoisted. . . . The steam shovel, from a mechanical standpoint, is a very uneconomical machine, and the cost of repairs is high.

"In the milling system the work grows in depth, and, after a given amount of stripping has been done, all of the ore uncovered may be removed before further stripping is necessary. When a block of ore has been mined, the pit thus made may be used as a place of deposit for the next stripping. It ought to be possible to utilize this advantage to materially reduce the cost of subsequent stripping, for the haul would be short, and by systematic methods the bottom of the stripping could be dropped into the bottom of the pit, and gravity would thus be made to assist throughout the work. . . . The one disadvantage of the milling system is the necessity of sinking shafts and putting in drifts and raises. The cost of this work per ton of ore obtained is, however, low, and, when we remember that in many of the deposits proper drainage can only be obtained by a shaft and by drifts in the bottom of the ore, this disadvantage is of little importance." After enumerating the advantages of open-pit working over underground methods, the writer sums up the disadvantages as being the necessity of providing a place for excavated material, the labor wasted in handling unsalable ore or glacial drift, and the increase in cost of working with the increase in depth. In comparing the cost of the two systems, he says that "the results show a difference of 21½ cents per ton of 2240 lbs. in favor of the milling system," and, after calculating the cost of the stripping he concludes with Mr. Larsson that, "where the volume of ore to be uncovered is equal to, or greater than, the volume of surface to be removed, it will pay to strip."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Technical Journals—See Introductory.

Metallurgy.

1326. Production of Aluminum (A brief history of the industry with some general results of experiments with iron and steel, and application to marine uses). Am Mech-Sept. 12. 1500 w.

1333. The Place of Tungsten in the Industries. F. Cremer (An excellent article giving the uses, properties, and adaptations). Ir Age-Sept. 12. 5500 w.

1334. Importation Probabilities (Editorial. Excess of demand over supply of manufactured iron with statistics from 1876 showing the tendency). Ir Age-Sept. 12. 700 w.

†1338. Recent Progress in Siemens-Martin Furnace Construction. Ch. Walrond (Notes on some of the improvements over the old furnace which increases the production and decreases the cost of the furnace repairs). Ind & East Eng-Aug. 10. 1800 w.

1355. History Repeating Itself in the Iron Trade (A detailed editorial on the condition of the iron industries). Eng News-Sept. 12. 1700 w.

1361. Steel-Making Experiments.—Results at Birmingham Indicating What Is Possible.—Brown Ores Suggested as Necessary. H. S. Fleming (Enumeration of companies making steel, with difficulties encountered, especially with southern ores and pig). Mfrs Rec-Sept. 13. 2000 w.

1407. Coke Making in the South of Russia. (Method of manufacture, with cost). Am Mfr & Ir Wld-Sept. 13. 600 w.

1420. Tina Amalgamation. Pazos y Sacio (The use of a copper in preference to an iron pan. A terse description of the South American methods of amalgamation). Eng & Min Jour-Sept. 14. 1800 w.

*1474. The Basic Bessemer Process (Editorial comment upon the production of basic steel in Germany). Ir & Coal Tr Rev-Sept. 13. 900 w.

1480. Abstract of Report of Committee on Standard Tests and Methods of Testing Materials. Gus C. Henning (Relation of silicon, sulphur, phosphorus, etc. on the physical and casting properties of cast iron. Diagrams of curves representing the expansion on cooling with recording apparatus). Am Mech-Sept. 19. 2100 w.

*1484. The Steel Plant at the Earl of Dudley's Round Oak Works. Ill. (Description with three half tone views of interior of a prominent English steel works). Eng, Lond-Sept. 13. 1500 w.

1495. Nickel Steel (Editorial comment on a paper read before the Am. Inst. of Min. Eng. Effect of corrosion and use of nickel nails on steel sheathing). R R Gaz-Sept. 20. 700 w.

1521. English Iron Works. Correspondence and editorial (Condition of English iron industry in comparison with that of Belgium and Germany. Comments on facts brought out by a visit of the British Iron Trade Association). Am Mfr & Ir Wld—Sept. 20. 2000 w.

1567. Smelting Refractory Ores in the Electric Furnace. George D. Burton (Remarkable success has been achieved). Elec Eng-Sept. 25. 1000 w.

*1589. A Competitive Trial of Flue-Heated Coke-Ovens. A. Hussener (Tests of ovens with vertical heating flues and air regenerators, with ovens with horizontal flues). Ir & St Tr Jour-Sept 14. 600 w.

*1590. Influence of Heat on the Tenacity of Manganese Bronze. M. Rudeloff (The limits of admixture and conditions influencing its application to machine parts). Ir & St Tr Jour-Sept. 14. 300 w.

1592. Production of Aluminum (A condensed review of the growth of the industry). Min Ind & Rev-Sept. 19. 1300 w.

1632. Concerning Pyrometers. Ill. (An electric pyrometer claimed to accurately register all temperatures, with preliminary tests). Am Mfr & Ir Wld-Sept. 27. 1200 w.

†1694. Electro-Metallurgy, as Applied to Silver Refining and Incidentally to Other Metals. George Faunce (A brief historical sketch followed by the principles involved and a b ief description of some of the processes used). Jour Fr Inst-Oct. 7000 w.

*1700. Continental Iron and Steel Manufacture (Report of the deputation of the British Iron Trades Asso. on the iron industry of Germany and Belgium. An interesting comparison). Ind & Ir-Sept. 20. 1600 w.

1742. The Bee Hive Coke Oven with Recovery of By-Products Ill. (Description of plant as employed in England). Ir Age-Oct. 3. 1200 w.

1743. Recarburation of Steel in the Basic Converter by Means of Calcium Carbide. A. J. Rossi (Referring to the production of acetylene from Ca C 2, and also experiments in Germany on carburizing steel by this carbide). Ir Age-Oct. 2. 800 w.

*1745. Linings for Thomas Converters (Method of preparation of lime or dolomite lining of basic Bessemer converters. From the Swedish paper *Jern Kont Annaler*). Ir & St Tr Jour-Sept. 21. 1700 w.

1808. Notes on Modern Steel Works Machinery. James Riley (Abstract of a paper read before the Inst. of Mech. Eng., Glasgow. Numerous examples of the various mill machines in use, with a description of their main features). Can Min Rev-Sept. 5000 w.

Mining.

1308. The Distribution of Power in Collieries. Ill. Llewelyn B. Atkinson (Favoring the generation of the entire power in one engine or pair of engines). Eng Mag-Nov. 3300 w.

We supply copies of these articles. See introductory.

1332. Flooded Mines at Black Hawk (Editorial. A disaster in a Colorado mine in which 14 lives were lost, caused by the water flooding the lower levels of the Fisk mine, breaking through into adjoining workings). Min Ind & Rev–Sept. 5. 1200 w.

†1337. Baragunda Copper Mine. Robert Oates (Brief description of an India copper mine. The reopening of ancient workings). Ind & East Eng–Aug. 10. 1000 w.

1369. South African Gold Fields (An editorial giving interesting statistics of this important gold producing region). Min & Sci Pr–Sept. 7. 1500 w.

*1379. Avondale Marble Company and Its Derrick. Ill. (Description of a very large derrick, covering a circle of 160 ft. in diameter, and lifting a weight of 100 tons). Stone–Sept. 2000 w.

*1380. Explosives. Wolcott C. Foster (An extended classification with valuable information on gunpowders and nitro-glycerine compositions). Stone–Sept. 2000 w.

†1398. The Iron Ranges of Minnesota. Map. Horace V. Winchell (Short descriptions of the various mines operated, with table of the Minnesota production since 1894). Pro of Lake Sup Min Inst–March. 5500 w.

†1399. Address by the President. J. Parke Channing (An original paper on the accidents to miners in the Lake Superior mines, with tabulated summary). Pro of Lake Sup Min Inst–March. 5000 w.

†1400. Distribution of Phosphorus and System of Sampling at the Pewabic Mine, Iron Mountain, Mich. E. F. Brown (A short paper showing where the highest percentage of phosphorus occurs in the ore body). Pro of Lake Sup Min Inst–March. 2500 w.

†1401. Efficiencies of Some Pumping Plants on the Menominee Range. Per Larsson (Comparison of the duty of some of the Cornish and Worthington pumps actually used, with cost sheets, and discussion). Pro Lake Sup Min Inst–March. 1900 w.

†1402. The New Pumping Plant at the Sterling Iron and Zinc Co., New Jersey. J. Parke Channing (Short description, with extracts from report of a duty test furnished by J. A. Van Mater). Pro Lake Sup Min Inst–March. 1300 w.

†1403. The Hoisting Plant of the Lake Mine. Ill. J. M. Vickers (Used by Cleveland Iron Co. at Ishpeming, Mich. Description). Pro Lake Sup Min Inst–March. 1600 w.

†1404. The Relation of the Vein at the Central Mine, Keweenaw Point, to the Kearsarge Conglomerate. L. I. Hubbard (General description of veins with four inset plates). Pro Lake Sup Min Inst–March. 3000 w.

†1405. Open-Pit Mining, with Special Reference to the Mesabi Range. F. W. Denton (Discussion of the various methods adopted, with their relative advantages). Pro Lake Sup Min Inst–March. 3300 w.

1418. A Central Station in Mining Work. Timothy W. Sprague (Descriptive of a central station for electrical power at coal mines on the Youghiogheny River, with map and section). Eng & Min Jour–Sept. 14. 2000 w.

*1424. The Douchy Colliery, Nord, France (Brief description of mines and methods of working. Output in 1894 was 341,677 tons of coal. Employees share profits). Col Guard–Sept. 6. 1200 w.

*1425. Use of Crucible Steel Wire Ropes in Mines (Mine hoisting. Description of rope with tests of the steel wire. The cost of rope per ton of ore hoisted per 1000 m. depth, was about 4 fr. Recommends small ropes in preference to large flat ropes). Col Guard–Sept. 6. 700 w.

1458. Kootenay Mining and Smelting Co. Limited. Ill. (Description of mine and smelter located at Pilot Bay, B. C.) West Min Wld–Sept. 14. 900 w.

1459. Some Calaveras Mines. E. H. Schaeffle (A general account of several California mines). Min & Sci Pr–Sept. 14. 2000 w.

*1483. Improved Steel Frame Stamp Battery for Wet Crushing (Description with engraving showing two double 5-stamp batteries supplied to a South African company). Eng, Lond–Sept. 13. 650 w.

1502. A Sand Filter for Chlorination Barrels. Ill. John E. Rothwell (Description). Eng & Min Jour–Sept. 21. 800 w.

1503. The Siemens and Halske Electric Rock Drills. Ill. W. Meissner (Description of a rotary and a percussion rock drill). Eng & Min Jour–Sept. 21. 3700 w.

*1504. On the Valuation of Mining Properties. F. J. Spence (An interesting article giving a number of practical considerations). Aust Min Stand–Aug. 17. 1700 w.

*1506. Progress of Ore Treatment on the Rand (Description of methods employed). Aust Min Stand–Aug. 17. 1800 w.

*1518. Three Tunnel Enterprises. Thomas Tonge (Colorado gold mines. These tunnels will drain a group of mines four miles in diameter). Min Jour–Sept. 14. 1200 w.

*1519. British Guiana's Gold Mining Industry (Editorial comment upon an official report, giving production statistics). Min Jour–Sept. 14. 1300 w.

1520. New Electric Power Portable Mine Drill. Ill. (A single post, universally mounted, friction screw feed, extensible, light, electric, one man, coal mine drill). Am Mfr & Ir Wld–Sept. 20. 800 w.

1538. Electricity in Gold Dredging. Ill. Ralph L. Montagu (A description of the electrical plant, with brief history of the old mining camp). Elec Wld–Sept. 21. 2200 w.

*1588. Winding Ropes in Deep Belgian Collieries (The use of a ten strand aloe flat rope under a working strain of 90 to 110 kilograms per sq. c. m. ; also crucible steel eight four-stranded parallel wire-ropes). Ir & St Tr Jour–Sept. 14. 500 w.

*1591. Chrome Iron Ore Mining in Asia Minor. W. F. Wilkinson (Description of occurrence with statistics of production). Ir & St Tr Jour–Sept. 14. 1800 w.

1607. A Modern California 20-Stamp Mill. Ill. (Description of plant with a stamp capacity of about 4 tons per stamp per 24 hours). Min & Sci Pr-Sept. 21. 450 w.

*1609. Machinery in South Africa.—Progress at the Gold-fields up to Date (Description of the machinery equipment of some of the gold mines). Mach, Lond-Sept. 15. 3700 w.

1631. Calcination of Spanish Ore (Description of method, kilns used and advantages in roasting the carbonate ores of Vizcaya). Am Mfr & Ir Wld-Sept. 27. 1400 w.

*1664. The Drainage of the South Staffordshire Mines (Removing the water from pounds which flooded the mines. Proposed methods). Ir & Coal Tr Rev-Sept. 20. 3300 w.

*1665. A Visit to the Gold Fields on the Hauraki Peninsula, N. Z. (Description of the various mines visited). Min Jour-Sept. 21. 3700 w.

*1667. Production of Gold, Platinum and Silver in Russia (Valuable mineral statistics). Jour Soc of Arts-Sept. 2. 450 w.

*1685. Experiments for Ascertaining the Comparative Effect of Explosives. Ill. (Details of experiments with results from eight high explosives). Col Guard-Sept. 20. 1800 w.

*1686. Bonneted Safety Lamps. James Ashworth (Article containing report of the Royal Commission. Results of observation and experiment). Col Guard-Sept. 20. 2800 w.

*1687. The Use of Steel Girders in Mines. E. Thompson (Abstract of paper read before the Fed. Inst. of Min. Eng. Showing advantage over timber). Col Guard-Sept. 20. 1600 w.

*1689. Meteorology and Mining. Abstract of paper by Joseph Thompson (Effect of atmospheric conditions in mine explosions). Col Guard-Sept 20. 2000 w.

*1690. Power Absorbed by Friction of the Shafts at the Supports—Co-efficients of Friction—Electrical Considerations. S. Hanappe (Experiments made at the School of Mines in Hainaut. Translated from the French). Col Guard-Sept. 20. Serial. 1st part. 1800 w.

*1691. Recovery of the Karwin Colliery. J. Kohout and J. Pilor (Method of advancing upon the demolished workings and the precautions adopted against the results of the explosion and fire). Col Guard-Sept. 20. 2800 w.

*1722. Legislation Against Brokers (Editorial comment on a proposed clause to the Mining Bill before the New Zealand legislature, preventing the stock-broker from dealing in shares for himself). Aust Min Stand-Aug. 24. 800 w.

*1723. How Gold Occurs in Nature. W. Nichols (An elementary general lecture delivered at Chicago). Aust Min Stand-Aug. 24. 1800 w.

*1737. Certain Dissimilar Occurrences of Gold-bearing Quartz. T. A. Rickard (A valuble paper by the Colorado State Geologist, illustrated by sections of known deposits in the several gold regions of the world). Aust Min Stand-Aug. 31. Serial. 1st part. 3500 w.

*1770. Some Notes on Brown Hematites. John S. Kennedy (A general paper giving production, composition, methods of prospecting and testing, with improvements in mining). Tradesman-Oct. 1. 2500 w.

1771. Accidents in Coal Mines (Roof-falls, shown to be the principal cause of fatal accidents, with suggestions for prevention). Tradesman-Oct. 900 w.

1772. Alcatraz Asphalt. Ill. (Method of working the deposits of the Alcatraz Asphalt Co. in Santa Barbara Co., Cal). Min & Sci Pr-Sept. 28. 900 w.

1805. Gold Mining in Nova Scotia. F. H. Mason (Showing the tendency of later practice, the reasons for decreased output, and the productions of the various districts during 1894). Can Min Rev-Sept. 2500 w.

1825. The Hartville Iron Ore Deposits in Wyoming. E. P. Snow (A red hematite iron ore belt having an area of 25 to 30 sq. miles, 8 miles from the railroad). Eng & Min Jour-Oct. 5. 1300 w.

1829. The Proportion of Inflammable Gas Necessary to Produce a Mine Explosion (Experiments with mixtures of the various mine gases with air, to determine the proportion of air necessary for explosion). Am Gas Lgt Jour-Oct. 7. 800 w.

*1874. Prospecting for Placer Gold. Ill. Arthur Lakes (Progress on the Roscoe Placer scheme at Clear Creek, Col. A description of the 10×6½ ft. flume and 48-in. Allen wooden stave pipe, with 9 sketches). Col Eng-Oct. Serial. 1st part. 1400 w.

*1875. The Ore Deposits of Cripple Creek. Francis T. Freeland (The geology, character and extent of this famous Colorado mining region briefly treated). Col Eng-Oct. 1600 w.

*1876. Cableways at Coal Strippings. Ill. (The suspended cableway in use for "stripping" the coal seam at the Coleraine Colliery, Beaver Meadow, Pa.) Col Eng-Oct. 500 w.

*1877. A Flume Conveyor—Coal for Coke Ovens Conveyed 8400 Feet by Water. B. L. Lloyd (Description of the Montana Coal and Coke Co.'s method of reducing the cost of handling coal, by means of an 8×8 ft. wooden flume 8400 ft. long to the coke ovens). Col Eng-Oct. 3000 w.

*1878. The Drainage of Flooded Mines. Baird Halberstadt (The self-dumping water tanks used at Lake Fridler Colliery in removing a large quantity of water. These tanks pour out at the top and are made of old boilers). Col Eng-Oct. 700 w.

1883. The Northeastern Coal Field of Illinois). Description of the mines at Gardner, Braceville and Clarke City. Geological phases; new machinery; the miners). Sci Am Sup-Oct. 12. 3000 w.

Miscellany.

1312. A Surface Copper Mine. Ill. (A description of Ledford's Copper Precipitating Plant, the largest in America. Produces 100 tons copper per month from the Anaconda and St. Lawrence mine water in Colo). W Min Wld-Sept. 7. 800 w.

We supply copies of these articles. See introductory.

1368. Taxation of Minerals in Mexico (Discussion of a 5% tax laid on gold and silver products in Mexico). Min & Sci Pr-Sept. 7. 800 w.

1416. United States Mineral Production and Prospects (Table giving the quantity and value of the various mineral and metallic substances produced in the U. S. during the years 1893 and 94). Eng & Min Jour-Sept. 14. 500 w.

1417. Mineral Production of New South Wales (Short abstract of the report of the Department of Mines and Agriculture. Table of production of various minerals during 1893 and 1894). Eng & Min Jour-Sept. 14. 400 w.

*1452. The British Iron Trade Deputation to the Continent (Comments on criticisms of the methods employed by British iron workers in gaining admission to German Works). Editorial. Engng-Sept. 6. 1700 w.

*1454. New Iron Works in the Ural (A mill taking the iron of four charcoal blast furnaces. Manufacture of railroad rails). Engng-Sept. 6. 700 w.

*1473. The British Association. Douglas Galton (Extracts from Presidential address before the British Asso. Comments upon progress during the past 60 years). Ir & Coal Tr Rev-Sept. 13. 4000 w.

1489. Petroleum in Peru. H. Polakowsky (A general description of these old oil wells). Sci Am Sup-Sept. 21. 700 w.

*1505. The Bromo-Cyanide and Bromo-Hypochlorate Processes. C. A. Mulholland (Results of experiments on the replacing of oxygen by bromine). Aust Min Stand-Aug. 17. 1400 w.

*1513. The Geology and Useful Minerals of the French Congo. Maurice Barrat (Abstract of an article in the *Annales des Mines*, giving (1) the geological formations, (2) the mineral deposits, and (3) conclusions). Col Guard-Sept. 13. 2500 w.

*1514. Coal in South-Eastern England. W. Whitaker (Address of President of the Geological Section of the British Asso. A general discussion on the occurrence of coal in this region). Col Guard-Sept. 13. 2600 w.

*1515. Present Position and Prospects of the Coal Industry. W. W. Millington (Abstract of an address by the President of the National Asso. of Colliery Managers, giving statistics and commercial conditions). Col Guard-Sept. 13. 750 w.

*1516. The Mining Congress in Hanover (Proceedings of the Congress of German Mining Engineers, who meet every three years). Col Guard-Sept. 13. Serial. 1st part. 1200 w.

*1517. Experiments on Centrifugal Fans. Bryan Donkin (Paper read before the English Inst. of Civ. Eng. Deductions from the results of practical tests. Nine cuts. Three tables. An excellent paper). Col Guard-Sept. 13. 5400 w.

1586. Minerals found in Western Carolina. Henry C. Demming (A list of the minerals with names of discoverer and person making the determination). Mfrs' Rec-Sept. 27. 700 w.

1596. As Seen by an Engineer (Account of a trip through the works at Trenton, N. J., the blast furnaces of the Lehigh Valley, the Bethlehem Iron Co., with a kindly reference to Mr. John Fritz, the eminent works engineer). Eng News-Sept. 26. 2800 w.

1633. Deep Water Way and Steel Making. Arthur J. Maxham (Read before the Deep Waterways convention. Shows the effect of transportation facilities on the local iron industries). Ir Tr Rev-Sept. 26. 1900 w.

1662. The Georgia Mineral Exhibit at the Atlanta Exposition (Description of the occurrence of each mineral with valuable information relating to its commercial importance). Eng & Min Jour-Sept. 28. Serial. 1st part. 4500 w.

*1688. The Origin of Petroleum. R. Nelson Boyd (A comprehensive treatise embracing theories of formation). Col Guard-Sept. 20. 2500 w.

*1738. Reasonable Geology. Frederick Danvers Power (A general article showing the popular conception of things geological and of ores with the methods of reasoning in geology). Aust Min Stand-Aug. 31. Serial. 1st part. 2600 w.

1803. Rare Minerals of the South (Some information relating to the various minerals, where they are found, and their commercial importance). Mfrs' Rec-Oct. 4. 4500 w.

1806. The Necessity of Competent Geological Surveys of Gold Mines (Abstract of a paper by Nicol Brown, read before the Geologists' Asso. of London, showing that a knowledge of geology is of first importance in exploiting for gold). Can Min Rev-Sept. 1200 w.

*1820. Coal Mine Explosions and Coal Mine Fires; Their Occurrence and Suppression. Ill. D. A. Louis (Fire-damp explosions, coal-dust fires and spontaneous conflagrations considered). Knowledge-Oct. 1. 4000 w.

*1824. Determination of Strength of Cyanide Solutions. Mr. Bethel (A paper read before the chemical and metallurgical society on some quick volumetric methods of analysis of McArthur-Forest Cyanide Solutions). Min. Jour-Sept. 28. 2200 w.

1826. Fractional Precipitation of Gold from a Solution Carrying Gold and Copper, with Hydrogen-Sulphide Gas. John E. Rothwell (Some results from actual practice by the process of fractional precipitation). Eng & Min Jour-Oct. 5. 900 w.

†1862. The Formation of Coal. Homer Greene (Interesting geological consideration of this subject). New Sci Rev-Oct. 3800 w.

1881. The Chinese in Our Gold Mines. Dan De Quille (An interesting account of the work of the Chinese in the mines, from their first coming to the present time. The author considers it a great mistake to have allowed them to do anything in the shape of mining, and thinks, all things considered, that they have no reason to complain of this country). Min Ind & Rev-Oct. 3. 2600 w.

We supply copies of these articles. See introductory.

MUNICIPAL ENGINEERING

Testing Water Meters.

THE time will come when the distribution of water to consumers in all large municipalities will be measured by meters, as is now that of gas,—that is, the use of water meters will be extended to the supply of private establishments as well as to large public buildings, hotels, office-buildings, manufactories, etc. No one with any show of reason can dispute that this is the only way whereby the cost of supply can be equitably apportioned, and wasteful consumption prevented. Those who do not have to pay in proportion to what they use and waste will, as a rule, continue to be wasteful, and the time is approaching fast in our larger cities when a limit to waste must be instituted.

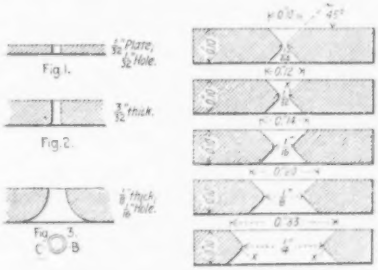
This premised, we see that the subject of uniform methods of testing water meters, ably treated in a paper by Mr. John Thompson before the Burlington meeting of the New England Water Works Association, and printed in a slightly condensed form in *Engineering News* (Sept. 19), is not only of present importance, but will be even more important in the future. The questions asked and discussed by Mr. Thompson imply the points of difference in present methods.

"(1) Should not the rating of meters, especially in low-flow tests, be by timing the deliveries of definite quantities, rather than by designating the diameter of jets? (2) What shall be the limit of the minimum rate? (3) What shall be the limit of the minimum rate? (4) Should tests be referred to the meter on the tank? (5) Should the error be indicated in pounds or percentage?"

He asserts that "low-flows should be designated by time rating," giving as reasons that time rating "is correct in theory" and that its superiority over other methods has been "demonstrated by long practice. . . . In testing a meter at low flow the only point desired to be known is what quantity is passing per minute or hour. If one meter, to operate accurately, requires a draft of 2 cu. ft. uniformly drawn in 1 hour, and another meter operates with equal accuracy upon a draft of 1 cu. ft. in the same time, then the latter has twice the sensibility of the former. The only function of a throttling diaphragm is to determine the rate of flow, and the only way of determining this is to carefully rate the perforation by measuring its discharge under a definite pressure for a definite period of time."

The variations of delivery through diaphragms of different thicknesses and having differently-shaped orifices are illustrated by Figs. 1, 2, and 3. Fig. 4 illustrates standard meter-testing diaphragms proposed by Mr. Thompson. "In Fig. 1 is represented, to large scale, a diaphragm, the original of which is 1-32 in. thick, the perforation being precisely 1-32 in. diameter, with the edges knife-sharp. The delivery of this orifice under a pressure of 50 lbs. per sq. in. is approximately 1 cu. ft. per hour. In Fig. 2 a diaphragm is represented to the same scale as Fig. 1, the original of which is 3-32 in. thick, having precisely the same diameter of orifice and the same knife-sharp edge on the upper side, but with the lower edge very slightly rounded by lightly scraping the edge with a sharp knife. The delivery of this diaphragm, under the same pressure as the former, with the upper sharp edge of the flow, is nearly 1.12 cu. ft. an hour. Hence the difference in thickness alone gives the thin diaphragm, at the pressure named, 12 per cent. less delivering capacity than the thicker one. Again, with this diaphragm reversed, the slightly rounded edge to the flow, the delivery is nearly 1.5 cu. ft. per hour, or 33 per cent. greater delivering capacity than from the sharp edge. These examples show how apparently trivial differences may greatly affect the comparison of results. Again, referring to Fig. 3, a diaphragm is represented in the original, of which the perforation is precisely 1-16

in. diameter, the thickness ⅛ in., one edge knife-sharp, and the other very nicely rounded to a curve of about ⅛ in. radius. This diaphragm, under a pressure of 50 lbs., each side being separately presented towards the pressure, gave the following results: with the upper edge to the inlet, the delivery was about 5.3 cu. ft. an hour; reversed, with the lower rounded edge to the flow, the delivery was about 7.10 cu. ft. an hour, or nearly 34 per cent. greater than the first. The well-known reason for this difference in delivering capacity is indicated in the circles *C* and *B*, the inner circle *C*, denoting the area of the contracted jet, from the sharp edge, while the outer circle, *B*, denotes the stream from the rounded side equal to that of the area of the orifice.



1, 2, 3. Diagrams Illustrating Results with Different Forms of Orifices in Meter Testing Diaphragms.

Fig. 4. Proposed Standard Meter Testing Diaphragms.

"The practical application of this to the present subject is as follows: suppose two meters equally accurate at 7 ft. an hour, and equally inaccurate at 5 ft. an hour. Then, furthermore, suppose that two water-works are supplied with these meters, requiring them accurate, according to their specification, on a jet 1-6 in. diameter at 50 lbs. pressure, and that it so happens that one of these works is provided with a diaphragm, sharp, as the upper side of Fig. 3, and the other works with a rounded perforation, as the lower side of said figure. Obviously, the works using the sharp-edged diaphragm will find the meter defective, whilst the other will accept its twin as correct. Evidently, had the meters been ordered to be correct at a minimum rate of 5 cu. ft. an hour, and had then been tested respectively under conditions to obtain this rate of flow, each purchaser would have been equally suited."

The standard diaphragms proposed are shown on an enlarged scale in Fig. 4, which gives their essential dimensions. The material named for them is hard-rolled brass. Of course the utmost care is demanded that the holes shall be made to exact dimensions, this being an operation within the skill of any good mechanic. "Both sides are made alike, in order that either side may be presented toward the inlet, and that the throat may be protected from injury."

Mr. Thompson then discusses "the limit of minimum rate," and describes, as illustrated in Fig. 5, a graduated valve for testing meters by time-rating; and in Fig. 6 he illustrates a meter-testing apparatus consisting of a galvanized iron can of 2 cu. ft. or 15 gallons' testing capacity, suspended by a bail on trunions from a spring scale, and having its inlet provided with a valve and standard diaphragm.

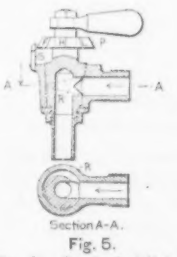


Fig. 5.

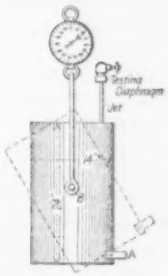


Fig. 6.

Fig. 5. Graduated Valve for Testing Meters by Time Rating.

Fig. 6. A Simple and Accurate Meter Testing Plant.

The "limit of the minimum rate" should be adapted to the conditions of the service. But the following general recommendation is ventured: "When the water is reasonably pure and free from grit, it is believed to be well within the power of manufacturers to regularly supply the smaller sizes of positive rotary and piston

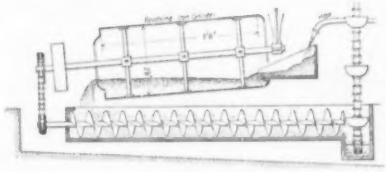
meters to indicate within 3 per cent. of accuracy at the rate of 1 cu. ft. uniformly drawn in 1 hour. And a meter which will do this may generally be depended upon to indicate, though not necessarily with much accuracy, down to from ¾ to ½ cu. ft. an hour. But the insistence upon such a degree of sensibility, except only where the water is free from grit, may invariably be taken as indicative of anything except good engineering sense." As to maximum rate practice differs widely; but, for sizes of service pipes of ½", ¾" and 1", a velocity of flow of 15 lin. ft. per second, representing respectively discharges of 1.8, 2.8, and 4.8 cu. ft. per minute, is considered as high as good practice will warrant; or, say, 2 cu. ft. for ½" or ⅝" meters, and 3.5 cu. ft. for a 1-in. meter. It is preferable to throttle the meter at the outlet, as this keeps the meter full under a regular pressure. Water should be turned on to an empty meter slowly, until the meter is completely filled," and "it is preferable to run a small quantity through the meter before starting a test." Measuring a discharge in tanks provided with glass tubes is liable to error from the capillarity of the tubes. Many other practical considerations and precautions are noted; and it is made evident that the accurate testing of water meters is not so simple and easy a matter as some have thought it to be.

The Hudson Water-Works Sand Washer.

In reply to a request for information made by the editor of *Engineering News*, Mr. George A. Soper of Gardner Road, Brookline, Mass., sent a drawing and description of a machine employed at the filter beds of the water-works at Hudson, N. Y. These were printed in the Sept. 12 issue of that journal. A striking feature in the operation of this machine is the remarkably low cost of cleansing sand by its use. Mr. Soper writes of it as follows:

"While I did not make a bacterial examination of the cleansed sand in connection with my recent investigation of the filter plant, and cannot in consequence state the percentage of bacteria removed, a general inspection of the method employed and of its apparent results satisfied me that the washed sand was quite clean enough to admit of a high efficiency of purification by the beds.

"There are two filters at Hudson, the larger one of which I shall take for illustration. Its area is a little less than a half-acre. To remove its carpet of sludge, together with about ¾ in. of sand, to a distance of 6 rods takes eleven men 9 hours, working with broad-bladed shovels and wheelbarrows. The sand is dumped into a bin freely exposed to the air, where it lies until successive cleanings of the bed necessitate a larger supply of available material for its renewal.



SAND WASHER.

"The bin for dirty sand immediately adjoins a small frame building, which contains the sand washer. When in operation, the sand is shoveled from its bin through an open door in the building upon a stage which acts as a kind of hopper. From the stage it is introduced into a revolving iron cylinder 2½ ft. in diameter by 5½ ft. in length, shown in the accompanying illustration. A copious stream of water and a slight inclination from the horizontal assist in causing the agitated sand to traverse the length of the cylinder, where it falls into a wooden trough 1 ft. square in section, and running parallel to the cylinder immediately beneath it. The trough being closed on both ends, and there being an abundant supply of water, a constant overflow takes place along its entire length, while the sand itself, sinking to the bottom, is conveyed back to the open doorway by means of a revolving iron helix fitting closely to the side of the trough. The overflow is relied upon to carry off the filth disengaged from the sand by attrition and immersed in the

water. Finally the sand is raised by an endless chain of buckets through the doorway to an outside platform 30 ft. above, and is there collected in wheelbarrows and dumped in a pile convenient to the filter bed. The engine is of 4 h. p. capacity, the boiler is of 5 h. p. capacity, and they easily turn the cylinder and the helix, and operate the buckets and pumps.

"When running, four men are employed at daily wages of $1.50, and the keeper and superintendent also lend their assistance. In this way about 32 cu. yds. of sand may be cleaned per day at a cost of about 20 cents per cu. yard. Supposing the maximum record rate of filtration, and remembering that for 2 months of the year the beds do not act as filters because of the impossibility of cleaning due to the frost, the cost of cleaning the sand may be estimated at about 16 cents per million gallons of filtered water. This is about 13 per cent. of the total cost of removing the dirty sand, washing it, and replacing it upon the beds."

Recent Improvements in Lighting.

THE following is an abstract of an address to the Association of German Engineers delivered by Dr. Wedding (*Gas World*, Aug. 10).

Dr. Wedding said that the Tesla light, though no doubt it will come,—in the next generation perhaps,—has not yet developed into anything practical. The chief interest of the address is in the numerical data, which afford a useful basis of comparison.

"A Welsbach lamp uses, on the average, 1.83 liters of gas (0.0646 cu. ft.) per candle, rising to 2.50 liters (0.0883 cu. ft.); most of the other incandescent lamps use from 3 to 5 liters to begin with, and go up to 6 liters, when the Welsbach is yet up to 2 1-2. In Trendel's Diamond light the consumption is under 2, and reaches 3 only after 200 hours, at which time the Welsbach is slightly under 2. Butzke's lamps are progressively improving: the earlier samples were 50 per cent. more than Welsbachs in respect of their consumption of gas; the latter only 17 per cent. The Butzke gives only about two-thirds the light of a Welsbach; it therefore uses actually less gas; and 60 candles is often too much, so that a Butzke may do well enough in many situations. Butzke's light is reddish; Kramme's is very white; Welsbach's is variable, for some parcels are white to greenish, others are yellowish to reddish; but all the competing makes seem to give a redder light, and a more pleasant one. But it must be remembered that the same quantity of energy, as red light, giving a visual intensity-energy measured as 1, will give, as yellow light, a visual intensity-energy of 28,000, as green light 100,000, and as violet light 1,600; whence it is important for illumination to economize energy by sending it out as green light. Acetylene, burned with air in a Berlin street lantern Bray burner (14 cu. ft. of gas, 40 candles), 47 per cent. acetylene, 53 air; light, 52 candles; consumption, 0.81 liter (0.0285 cu. ft.) acetylene per candle; consumption per candle increased 50 per cent. by diluting the acetylene with carbonic acid instead of air. Enrichment, plain gas, 15 liters (0.529 cu. ft.) per candle; 4 per cent. acetylene, 7 liters (0.247 cu. ft.); 12 per cent., 4 liters (0.142 cu. ft.); 21 per cent., 3 liters (0.106 cu. ft.) per candle.

"The order of cost is; arc lamps, per 16 candles, 0.60d. per hour; Welsbachs, 0.06d. to 0.84d.; spirit Welsbachs, from 0.84d. to 0.24d.; petroleum (at 19⅔d. per gallon), about 0.24d.; argand gas, about 0.3d.; electric incandescent lamps, 0.433d.; acetylene at present prices (carbid 6d. per kilogram) in a regenerative burner (0.026 cu. ft. per candle), 0.6d. per hour. Recent makes of very small arc lamps (Niewerth and Co.) give an average of 40 candles (maximum 65) with a consumption of 40 watts per hour: that is, where current costs 5d. per Board of Trade unit, an hourly cost per 16 candles of 0.08d., with the advantage that the rays are better reflected from the walls and things look brighter than amid the predominantly green rays of a Welsbach, which are not well reflected from dark walls and objects,"—a fault in this lamp not generally appreciated.

The Hermite Process of Purifying Sewage.

THIS process was the subject of a paper by Mr. J. Napier, read before Section G, of the British Association, at its late meeting, an abstract of which is contained in *Engineering* (Sept. 20). The process appears to have merit, and an outline of its nature and mode of application is timely. "Hermite" is a trade name for a deodorizing and disinfecting solution which, it is claimed, can be made cheaply enough to warrant its use for deodorizing sewage on a large scale. The process of manufacturing it consists of passing an electric current obtained from a dynamo through sea water or a solution containing magnesium and sodium chlorids. A portion of the chlorids is converted into hypochlorite,—a substance which disinfects, deodorizes, and bleaches in a way similar to that in which the active ingredient of bleaching powder acts. This solution is called the electrolyzed or "Hermite" solution, and may contain from ½ to 1 gram of active chlorine per liter. The author gave a brief history of the sewering of Ipswich during the last 20 years, showing the present system, particularly the position of the main sewer as it passes through the town to the outfall. The deodorizing effects of the solution on sewage, especially upon that in the main sewer of Ipswich, were dealt with, and the results of trials made in August and September, 1894, and in June and August of this year were given.

In the discussion that followed the reading of the paper, Mr. T. S. Elliston remarked "that in the electrolyzed sea water there was a powerful deodorant, and also a strong disinfectant that could be manufactured in bulk at a small cost. He urged that the plant should be sufficient to electrolyze the solution in the full strength of 1 gram of active chlorine per liter. He put 950 gallons of the strong solution of 1 gram per liter at the head of the main sewer, and for more than ½ mile could distinctly trace the chlorine smell at the manholes. A sample of the sewage was taken out after being treated, and was found to contain 5 per cent. of the solution. After it had stood 6 days, it showed no signs of decomposition, whereas a sample removed a short time before the solution was added was offensively putrid at the time. This he considered a very satisfactory result. They were only trying the main sewer, it being thought that the sewer gas was generated there and driven up the arterial system. In the speaker's opinion sewer gas was extensively generated in the arterial system of sewerage, and became equally offensive there. When sewers were complained of, it was often the fault of the house drain. Mr. Elliston would like to see sufficient plant put down to work the solution up to its full strength, and to have a reserve for treating special localities. There was one advantage of this system,—that it acted as a flushing system. After a hot dry summer, the subsoil became warmed so that, as the temperature of the sewers rose to 55 deg. Fahr., or thereabouts, the putrefying changes in the sewers became more rapid, and the flushing of the sewers constantly with the fluid not only acted as a deodorant, but reduced the temperature as well."

MR. JAMES MANSERGH, M.I.C.E., is to report on the waterworks system of the city of Toronto, which, it is said will take him a month to complete. Toronto has a population of 200,000, and is deprived of its water supply owing to a break in the conduit pipe by which water is procured from Lake Ontario. The necessary repairs cannot be effected for several weeks. In the meantime water is being procured from the surrounding villages, whence it is carried to the city by means of puncheons, barrels, and watering carts, the public being put to very serious inconvenience.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Municipal Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Gas Supply.

*1413. Some Experiences in Gas Purification. R. G. Shadbolt (Attempts to reduce cost. Results attained. Discussion by members). Gas Wld–Sept. 7. 5000 w.

1446. Mechanical Stoking in Retort-Houses

We supply copies of these articles. See Introductory.

(An able review of progress in mechanical stoking of gas-retort furnaces. Abstract of papers read respectively by Alexander Wilson and Andrew S. Biggart). Pro Age-Sept. 16. 3000 w.

1447. A Chart of Active Gas-Securities (A graphical indication of prices of gas stocks from Jan., 1895, to June, inclusive). Pro Age-Sept. 16. 1500 w.

*1465. The Bradford Oil-Gas Controversy (Interesting and Important. Gives report of expert, Mr. Lewis T. Wright, upon Dvorkovitz oil gas process, to the South-west of England District Association of Gas Managers; report of Mr. Thomas Newbigging, expert in the interest of the promoters of this process; a supplementary report by Mr. Wright; a reply to this report by Mr. Newbigging, criticising Mr. Wright's supplementary report and pointing out an alleged mistake in his calculation; a criticism of Mr. Wright's report by the corporation gas engineer; and the terms of an offer made by the agent of the owners of the Dvorkovitz patents, in which a guarantee is made that the cost of enrichment by this process shall not exceed one half-penny per candle-power for every 1000 feet of gas supplied for consumption. Followed by a long discussion). Gas Wld-Sept. 14. 11000 w.

*1476. The Manufacture of Sulphuric Acid by Sulphate of Ammonia Make s. Fletcher W. Stevenson (Describes a profitable industry which can be carried on by makers of sulphate of ammonia, the sulphur of the sulphuretted hydrogen being converted into acid). Gas Eng Mag-Sept. 10. 3300 w.

*1634. The Manufacture of Sulphate of Ammonia (A discussion at a meeting of Eastern Counties' Gas Managers Asso. (English) on the feasibility, profits and practical methods of manufacturing sulphate of ammonia in small works). Gas Wld-Sept. 21. 2500 w.

*1635. The Bradford Oil-Gas Controversy. Interview with Dr. Dvorkovitz (The Dvorkovitz oil-gas process having been pronounced a failure by the Bradford (Eng.) authorities, upon an adverse report of an expert employed to investigate its claims and its practical results, this interview affords the opportunity for a criticism of the report by the inventor. The adverse report has also been criticised by other authorities and it is questionable whether the report is not as likely to aid the introduction of the new process as to retard it). Gas Wld-Sept. 21. 2700 w.

1711. Recent Appearances upon the Field of Illumination by Gas. H. Bunte (From report of a paper read at Cologne, before the 35th annual convention of the German Union of Gas and Water Engineers. The first number discusses argon, thorium and calcium carbide). Pro Age-Oct. 1. Serial. 1st part. 4500 w.

1712. Tests of the Welsbach Incandescent Burner. E. V. Stebbins (Abstract of a thesis in Elec. Engng., Sibley College. The object of tests was to determine the general properties of the lamp, including its life curves; its candle-power; the deterioration in the same and in its color; its radiant efficiency; the difference in the parts of its mantle; the absorption by various globes in common use; and, generally, its properties and powers as a source of light). Pro Age-Oct. 1. 2000 w.

1744. The Browne Gas Process. Ill. (The vaporizing of petroleum and passing it through incandescent heat). Ir Age-Oct. 3. 600 w.

*1853. M. Bansept's Gas-Mixing Method (Describes a method of gas-mixing, whereby, it is claimed, a mantle of more solid material than is used in the Welsbach system may be employed, and a noteworthy increase of illuminating power may be gained). Gas Wld-Sept. 28. 2200 w.

Sewerage.

1415. The Proposed Sewerage of Independence, Mo. (Abstract of a report of the designing engineer, Mr. Wynkoop Kiersted). Eng Rec-Sept. 4. 1100 w.

†1435. Sewage Disposal in Small Towns—Practical Examples in England.—Cardiff (Abstract of Consular Report to the State Department). San-Sept. 2200 w.

*1636. The Drainage of Villages. William Spinks (The first number deals principally with statutory powers before entering upon the engineering side of the question, which will be discussed in future numbers). San Rec-Sept. 20. Serial. 1st part. 1400 w.

*1681. The Hermite Sewage Process (Paper read before the mechanical section of the British Asso. by J. Napier, with discussion. Both the paper and discussion give practical experience favorable to the process, which consists in deodorizing sewage by the action of hypochlorite produced by the action of the electric current upon the chlorides contained in sea-water). Engng-Sept. 20. Serial. 1st part. 1600 w.

†1832. The Disposal of Sewage for Industrial Communities in India (Describes the system of dry earth latrines in use in India, which is said to be perfectly sanitary and very satisfactory). Ind & East Eng-Sept. 7. 2000 w.

1871.—$1.50. The Separate Sewer System Without Automatic Flush Tanks. F. S. Odell, with Discussion (An argument to prove that automatic flush tanks are not an essential feature of a separate sewer system, and that where any sufficient reason exists for their omission, as where water supply is insufficient, or too costly, they may be dispensed with). Am Soc Civ Eng-Sept. 4200 w.

Streets and Pavements.

1675. Street Cleaning in Germany (Reprinted from the *Surveyor*. Describes methods of street cleaning. (1) Where the cost is borne by the municipal authority. (2) Where borne by owners of property along the line. (3) Where shared by owners of property and the community. The methods in forty-two German cities are quoted). Eng Rec-Sept. 28. 900 w.

*1713. Differences in Specifications for Vitrified Paving Brick. W. G. Wilkins (The author gives a large amount of useful information drawn from personal experience and investigations of specifications in use in different municipalities; these investigations having been made for

the purpose of improvement in his own specifications as chief of the bureau of engineering and surveying in the city of Allegheny, Pa. Paper read at the Soc. of Municipal Improvements, with Discussion). Paving & Munic Engng–Oct. 2800 w.

*1717. Experience in Several Cities with Brick Paving (A general discussion by members of the Am. Soc. of Munic. Improvements relating to practice in various municipalities). Pav & Munic Engng–Oct. 1000 w.

Water Supply.

*1309. The Pike's Peak and Colorado Springs Water Works. Ill. Arthur Lakes (An account of the drainage system, existing and contemplated, for the supply of water to Colorado Springs from the lakes of Pike's peak, including a description of the "iceberg idea"). Eng Mag–Nov. 3000 w.

1356. Sand Washer for the Filter Beds of the Water-Works of Hudson, N. Y. George A. Soper (A communication describing and illustrating a machine for washing the dirty sand removed from filter beds). Eng News–Sept. 12. 450 w.

1359. Electrolytic Corrosion of Water Pipes in Boston (Results of the investigation of experts on the effect of electric ground currents upon water pipes. Embodied in the An. Report of the City Engineer of Boston). Eng News–Sept. 12. 500 w.

1378 New Jersey's Watersheds (Estimate of the supply from various sources; correction of some errors relative to these sources, and suggestion that by draining some wet lands in the state, the poor farmers along the Ramapo River might be induced to vacate their impoverished lands along the banks for the more fertile drained lands, thus removing one source of pollution). Fire & Water–Sept. 14. 1100 w.

*1423. Bouches-du-Rhone Colliery Outfall Drift—Difficulties from Feeders (A scheme for obtaining water supply from the outfall drift named, for the city of Marseilles, with a population of 400,000. An extremely interesting article). Col Guard–Sept. 6. 4800 w.

1462. Uniformity of Methods in Testing Water Meters. John Thomson (Investigation of best method to measure water supplies, with cuts showing orifices used, also a graduated valve meter and graduated tank meter). Eng News–Sept. 19. 4200 w.

1464. The Milwaukee Water-Works Intake. Ill. (Construction of a tunnel under unusually difficult conditions. A very interesting description of an 8200-ft. submarine intake into Lake Michigan). Eng News–Sept. 19. 4200 w.

†1549. Water Supply in 1894 (Editorial. Takes the ground that the bacteriologist will supersede the chemist in the determination of the wholesomeness of water, the chemist's duties ceasing with the primary analysis of the constituents before the source of supply is decided upon). Ind Engng–Aug. 17. 1400 w.

*1658. The New Westminster Waterworks. Arthur Edmund Breton Hill (From Pro. of Inst. of Civ. Eng. of Eng. History, description and itemized table of cost of the works up to Dec., 1892, in which year the water was turned into the main). Eng, Lond–Sept. 20. 1300 w.

1674. Municipal Provision of Hydrants (Gives the number of fire hydrants per mile, and the number per thousand of population, for more than twenty American cities). Eng Rec–Sept. 28. 200 w.

*1714. Impurities in Public Water Supplies. John W. Hill (A broad review of the subject. Paper read before the Am. Soc. of Munic. Improvements, followed by discussion). Pav & Munic Engng–Oct. 3600 w.

1870.—$1.50. Consumption and Waste of Water. Dexter Brackett, with Discussion (Gives a tabular statement of water in different municipalities which shows that rate of consumption is increasing more rapidly than population. Also tabulated statement of water used for domestic purposes from which data it is concluded that on an average at least 50% of the water consumed in American municipalities is wasted. Causes of waste separately discussed, and for which remedies must be found, are defective plumbing, defective street mains and services, waste for preventing freezing of services, and wilful waste). Am Soc of Civ Eng–Sept. 12000 w.

1872.—$1.50. Experiments on the Discharge of a 30-in. Stop Valve. J. Waldo Smith, with Discussion (Tabulated results and diagrams showing graphically coefficients of discharge, and cuts illustrating arrangement and construction). Am Soc Civ Eng–Sept. 2400 w.

Miscellany.

1419. The Manufacture of Paving Brick in Central Iowa. L. Balliet (Quality of clays; general geological section in the region of Des Moines; kilns; mixtures, etc). Eng & Min Jour–Sept. 14. 1500 w.

*1682. Public Hydraulic Power Supply. Edward B. Ellington (Review of the municipal hydraulic power now supplied in a number of cities. This first number deals with the system as carried out in Glasgow). Engng–Sept. 20. Serial. 1st part. 2500 w.

*1715. Experience with Improved Streets and Sewers. W. B. Holton (Recounts instructive experiences in Indianapolis. Paper read before the Am. Soc. of Munic. Improvements, followed by discussion). Pav & Munic Engng–Oct. 3000 w.

*1716. Disposal of Garbage. Thomas De Vilbiss (Paper read before the Am. Soc. of Munic. Improvement, with Discussion. Treats of collections, the character of vehicles used for this purpose, and systems for destroying and disposing of garbage. Interesting experiences are narrated). Pav & Munic Engng–Oct. 4000 w.

1793. Garbage Collection and Disposal at Pittsburg, Pa. (A detailed description of the system, with illustrations of garbage wagon. Disposal is effected by the method of the American Reduction Co., in which the material is first treated with steam in digesters, and subsequently dessicated for use as a fertilizer). Eng News–Oct. 2800 w.

RAILROADING

American and British Railways Compared.

THE *Railway Age and Northwestern Railroader* (Sept. 13) contains an interesting compilation of figures from Poor's Manual of American railroads and the British board of trade returns for English railroads, with editorial comment. The operating conditions in these two nations are quite dissimilar, and for that reason the figures given are instructive, as showing the relation between capitalization, mileage, and passengers and freight carried. "The following are the principal items from the two reports which are capable of comparison :

For the year 1894.	United States.	Great Britain.
Miles of railway.....	179,279	20,908
Capital stock and debt...	$11,565,600,000	$4,926,936,000
Earnings—passenger. ..	276,031,571	154,312,529
" freight	700,477,409	216,895,390
" other.....	91,134,533	28,164,795
Total traffic revenue.....	$1,067,643,513	$399,372,714
Operating expenses.....	757,765,739	236,041,565
Net earnings	309,887,774	163,331,265
Passengers carried.....	583,248,007	*911,412,926
Tons freight moved.....	675,129,747	324,416,222
Rd. & equip't. Cost pr m.	55,641	235,648
Earnings per mile.....	6,085	19,100
Exp. to earnings. Per ct.	70.24 p. c.	56.00 p. c.
Pas'r earn'gs. Pro. of gr.	25.85 "	43.29 "
Freight " " " "	65.61 "	51.45 "
Other " " " "	8.54 "	5.26 "
Int. and div's on capital.	2.89 "	3.77 "
Locomotives, number....	35,813	18,328
Passenger cars, " ...	26,345	41,500
Bag. & mail cars, " ...	7,937	16,161
Freight cars ..	1,191,866	608,079

*Also 1,184,861 holders of season tickets.

"It will be seen that, while our mileage is nearly nine times that of the United Kingdom, our railway capital is only two and one-third times as great, our gross earnings are but two and two-thirds times as great, and our net earnings lack considerable of being twice as great. But, as for passengers carried, the British roads beat us nearly two to one, without counting the unnumbered trips of 1,184,000 British season-ticket holders ; and, although our foreign tonnage is more than twice as great as theirs, the earnings per mile of road were considerably more than twice as great in Great Britain as in the United States. The better results in net earnings on British roads are largely accounted for when it is seen that our operating expenses are very much larger per mile than theirs, standing at over 70 per cent. against 56 on British roads. With such a difference in the ratio of expenses, it is not strange to find that the British roads last year earned 3.77 per cent. on their much heavier rate of capitalization, while the rate earned by American roads averaged only 2.84 per cent. But it is also a very important fact that the earnings of our roads averaged only $6085 per mile, compared with $19,100 per mile earned by British roads."

Gas Street Railway in Dessau.

IN a recent number of the *Progressive Age* (Sept. 16) General Superintendent W. von Oechelhaeuser describes the street railway of Dessau, Germany, which is operated by gas engines entirely. The line was originally 2¾ miles long, and went into operation in November, 1894, with an equipment of nine gas motor cars. It now has a mileage of 3⅞ miles, and nine 7-h. p. and four 10 h. p. motor cars, with four tail cars. As gas engines need neither water or coal, which are sometimes not very available in isolated localities, the gas engine has received considerable attention, especially from mining men, but its direct competition with steam and electricity is rather a rarity. The author states that "the three chief elements in gas-traction are: the gas-storage, the gas engine, and the driving-mechanism ; and of these the public is accustomed to take the greatest interest in gas-storage. It is here important, before all things, to remove a prejudice (namely, the fearful spectre of a supposed danger of explosion) by bringing it so closely home that we can recognize it as in fact it is,—as an apparition without real existence. For facts show that the transportation of gas under high pressure, and its burning during transit, has taken place for more than 25 years with the well-known and excellently-chosen Pintsch sys-

tem, in more than sixty thousand railway passenger cars, at home and abroad, actually without a single explosion; and that no one who travels in these cars thinks of danger of explosion or has the slightest reason for doing so. . . . . The second point of interest in relation to the question is: will the wear and tear of gas engines, operating gas street railways, not be too great? Naturally the first half-year's operation, as in Dessau, can give no direct answer to this question from experience. We are in a position, however, to draw indirect conclusions from the operations of stationary gas-engines. In this connection, the company which I represent has undertaken an inquiry of all the owners of such, and of some of the larger gas-engine shops outside of our company, resulting in a reply exceptionally favorable. From most of the owners the almost stereotyped answer came back that in most cases the repairs were limited to the replacement of piston-rings after a considerable period of operation, to the re-scraping of slide valves (of the engines of older construction, the later motors possessing poppet valves almost entirely), and to re-packing joints, —a point which can be cared for with an insignificant cost of material and by the ordinary personal attendance. The reports from gas-dynamos are also very favorable." The author shows that at the electric central station at Dessau the cost of repairs during a period of 8½ years, for the 10, 30, 60, and 120 h. p. motors, has been less than $\frac{1}{80}$ of a cent per horse-power per hour, or one-eighth of one per cent. of their first cost per year. The 350-h. p. gas engines at the station at Sophia Island at Prague, during a period of 8 years, cost nothing for repairs, while the 12-h. p. gas engine at the State House caused an expenditure of $37.20 in a period of 9 years. "A brief inspection of the gas engine of the Dessau cars has shown that the working cylinders are as smooth as a looking glass inside, and reveal to the gaze not the least alteration of dimension or unequal wear in the two ends of the cylinder, which fully establishes from this first half-year's operation that we have nothing to fear from dust. The driving mechanism is protected from dust and dirt by a special casing." A charge of gas will run the engine 6 to 8 miles. Ordinary illuminating gas is found more desirable than the richer gases. The consumption of gas per car-mile is 16.58 cu. ft., the quantity used at the compression plant bringing it up to 18.37 cu. ft. Details of operation are shown by the following table:

DATA OF OPERATION OF THE DESSAU GAS STREET RAILWAY.

Month, 1895.	Number of motor-cars in daily use.	Useful car-miles.	Number of passengers carried.	Volume of compressed gas.	Gas-consumption of engines driving compressors and work-shop.	Total gas consumption for power.	Gas compressed per useful car-mile.	Total gas used per useful car-mile.	Percentage of compressed gas used in compr.
				Cu. ft.	Cu. ft.	Cu. ft.	Cu. ft.	Cu. ft.	
January.....	7	13,038	47,250	356,967	63,864	420,831	16.97	20.04	14.6
February.....	7	12,476	35,995	335,590	56,342	391,932	16.69	19.48	13.9
March.....	8	14,513	52,470	388,197	64,005	452,202	16.58	19.33	12.8
April.....	8	14,579	61,900	382,050	61,252	443,302	16.26	18.88	11.9
May.....	8	16,489	70,552	439,254	72,057	511,311	16.51	19.23	13.5
		71,095	268,167	1,902,058	317,520	2,219,578	16.58	18.37	

Norfolk & Western System of Maintaining Standards.

OVER the initials A. S. in *Locomotive Engineering* (Sept.) we find some interesting notes on a subject which all acknowledge to be of great economic importance, and which few roads possess in such a well-developed state. The department of motive power is under a man who has

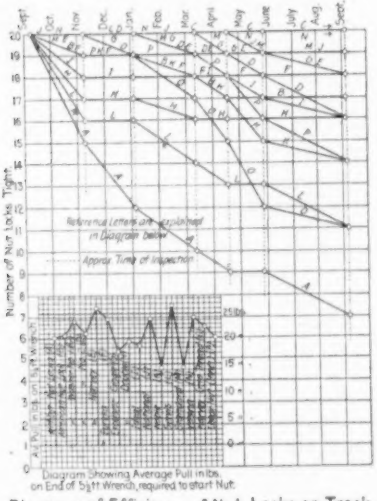
systematized the work thoroughly; all material purchased or handled is subject to chemical and mechanical tests in a specially-designed laboratory; drawings are arranged according to classified catalogue; and the store house and shop management have complete records of material and labor. "Perceiving the advantage it would be in the interest of uniformity that every man in charge of repairs should possess a record of standards adopted or of changes made on existing standards, Mr. Soule, the superintendent of motive power, instituted a system of circular 'notifications of standard,' which is sent to every official in charge of work. These notifications of standards give a brief description of the form adopted, and refer to the blue print, which contains full particulars. The notifications are sometimes of standards adopted, and at other times they relate to standards changed or to new designs. Occasionally they notify all concerned of a new style of some article which has been adopted, or a changed location for some attachment. One of the latest notifications reads: 'Hereafter counterbore bolts, as per print S. C. 97, should be used in locomotive construction and repairs, instead of countersunk bolts such as have hitherto been generally used. These counterbore bolts should not only be used in all new work, but should also be used in renewals of old work whenever possible.' The total number of these notifications has been about three hundred and fifty. They relate to every variety of detail of locomotives and cars. As these notifications would be confusing after they became numerous, they have been indexed, so that a master mechanic, car-builder, or general foreman, wishing to know what has been done concerning any particular part, turns up the index and has the information at once. . . . The practical effect of the system is the promotion of uniform practice in the repair shops and a tendency to make parts interchangeable. This reduces the cost of repairs, and facilitates doing so much of the work promptly that the clerical expense of keeping the system going cuts no figure."

The Baltimore Tunnel Electric Locomotive.

SPECULATION is active in electrical circles in all its phases, from the visionary to the practical, concerning the place the electric motor will occupy in passenger and freight traffic. The direct cause is the placing of a large electric locomotive in the tunnel leading into Baltimore, where it is now successfully doing the work of a steam locomotive. *The Railroad Gazette* (Oct. 4) states that "the contract requires the engines to haul fifteen loaded passenger cars and a locomotive at 35 miles an hour, and thirty loaded freight cars and locomotive at 15 miles an hour, through the tunnel up an 0.8 per cent. grade; the object is to keep the tunnel free from locomotive smoke, which would, of course, be aggravated when pulling up the grade. . . . Going westward, the trains run through without steam, the grade descending at 42 ft. per mile all the way." The successful working of this motor under heavy loads has led many to jump at the conclusion that the electric motor will in the near future displace steam locomotives in railroad service. The trend of the views of those qualified to advance opinions has been to the effect that electricity cannot be profitably used for heavy through traffic, but will monopolize local passenger trade and handle light local freight. The article says that, "whatever may be the outcome of the use of electric locomotives in the Baltimore tunnel, there is one valuable practical lesson already,—*viz.*, there is a possibility of getting any reasonable pull with an electric locomotive. This fact will be impressed on the mind of any one who sees the machine take hold of a train of thirty cars and start them without using the slack. A far better example is found in suburban street-car lines. It has been said in the press reports that the Baltimore electric locomotive has reached 61 miles an hour. This is quite probable, as there is sufficient power to drive the locomotive and several cars at 100 miles an hour, if the motors were all placed in multiple instead of series." It will be interesting to watch the growth of this new departure.

Efficiency of Track-Bolt Nut Locks.

MUCH in the same way that illustrations and drawings are taking the place of written descriptions, the results of experiments are being expressed in diagrams, which not only are understood at a glance, but separate and condense what we wish to know from a wearisome collection of recorded observations, many of which require corrections and allowances. This system of condensation, and this effort to make complicated things easily understood, are evident, we are glad to say, with most of our best modern scientific writers, while the devotees of the infinitesimal calculus and Latin phrases are rapidly becoming obsolete. We have an example of systematic work in a paper by Mr. G. E. Hayward, part of which is published by the *Engineering News* (Oct. 3). The record of these tests is given in the accompanying diagram, while the methods of making the experiments are thus explained:



Diagrams of Efficiency of Nut Locks on Track Bolts.

"The diagram represents the result of test beginning Sept. 8, 1892. There were twenty samples of each of fourteen kinds of nut locks placed in the track, and against these twenty bolts without nut locks and twenty with check nuts were tested. They were placed in the main track (Zanesville & Ohio Ry.), on tangent, 1 per cent. grade, the track having 56-lb. rails, 4-bolt angle bars, and ¾-in. bolts with hexagonal nut ¾ in. thick. The traffic was light, and the maximum engine weight, without tank, was 94,000 lbs. No switching was done over this track, which insured the same traffic over all the samples tested.

"The locks were placed, and nuts set up until they were pronounced tight. Then they were gone over again, and care taken to have each screwed up flush, except in the case of the Standard, where 20 per cent. 'set' was left, according to instructions from the manufacturer. After the test in the track was completed, the pull necessary to start the nut forward was measured, the pull being exerted on the end of a 5½-ft. wrench. The diagram shows the average for each kind. The results are simply for comparison. Effort was made to secure uniform conditions in all ways possible, in order to offset the fact that the number placed was limited.

"As is shown, the Verona and American Lock Washer No. 1 held all the bolts to which they were applied, with several other nut locks as close competitors. It is not claimed that it is a conclusive test. There are some conditions which cannot be made equal, such as differences in bolts and ties, though ties were of very fair quality, and bolts alike; yet it gives a general idea."

Metal Tie-Plates.

REPRESENTATIVES of the Goldie, the Servis, and the Churchwood tie-plates appeared before the Northwest Railway Club and debated upon the relative merits and defects of their several plates. The animated discussion brought to light a number of facts which the *Engineering News* (Sept. 12) has jotted down. These plates are intended to be placed between the steel rail and the wooden tie to prevent wear on the latter and at the same time to help hold the rail firmly. The article places the discussion under five heads, *viz.*, "(1) rib and flat top; (2) width of plate; (3) thickness of plate; (4) bottom ribs and teeth; (5) shimming."

The ribs are of two kinds, one along the edge of the rail to the outside, preventing outward movement, and the other at right angles to the rail, being recessed where the rail sets in place. The idea embodied by both is to prevent any lateral motion of the rail and wear upon the spikes.

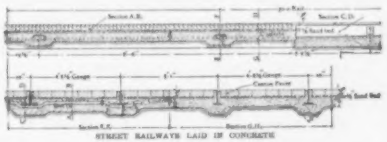
But this precaution does not seem imperative, though many roads require it. The flat top plate seems to give as good results when the spikes are so driven as to prevent initial play. As to width of plates, "while one maker advocates narrow plates so as to concentrate the load near the middle of the tie and thus approximate to an ideal bearing narrow on top and wide at bottom, another maker claims that such plates increase the distance between the rail supports, thus reducing the stiffness of the track." The fact was brought out that wide plates, 6 in. or over, tend to produce rocking of the ties, and the suggestion was made that an increased number of narrow ties with narrow plates (3¼ in. wide) would be desirable. Thickness of the plates is determined by the strength necessary to resist buckling, as the wear is found to be small. Therefore a light plate stiffened by corrugations or ribs is as desirable as a plain thick plate. The corrugated plate shown was 3-16 in. thick, while the thick plates are made as much as ½ in. thick. "In respect to the method by which the plates are attached to the ties, the plates may be divided into two classes: first, those in which the projections are lengthwise with the tie and approximately parallel with the fibers; second, those in which the projections are transverse to the tie and cut across the fibers . . . It is certain that a tie plate must in some way be self-attached to the tie, so that it will not move under the traffic, but it appears doubtful whether any provision to prevent such a plate from moving lengthwise on the tie is necessary."

The sharp-edged grips or spikes seem to give best results, as they are less liable to displacement than the more obtuse projections on the underside of the plates. When the rail is raised by putting in liners under it, or "shimming," it is found better to leave the tie-plate in place and to put the shimming on top of it. "The tie-plate is intended to be a permanent part of the tie, and should never be removed to allow for the temporary expedient of shimming."

Street Railway Tracks Laid in Concrete.

ONE of the evils of the system of laying pipe, railway track, and underground wires in our streets is the necessity of tearing up the street and obstructing travel whenever repairs are necessary. The tendency toward improving this condition is shown in some new construction described in *The Railway Review* (Sept. 28).

"With a view of establishing a road bed which will require the minimum outlay for maintenance, the Detroit Citizens' Street Railway Company has adopted a construction for its tracks which seems to be the best and most durable which has yet come to our notice. The laying of track upon concrete, which is the method adopted in this case, has been tried in other cities, and has given satisfaction, especially in Montreal and Toronto. It is, therefore, not a new thing. The illustrations show the method adopted for the Jefferson and Gratiot avenue lines, in which it will be seen that the rail is of the girder type grooved and 9 in. high, the section being 100 lbs. to the yard. The track is held to gage by steel ties, which are from 4 to 5 ft. apart center to center; and, beside acting as tie-rods, these are supposed to assist in maintaining the surface of the track. It is doubtful, however, if they are necessary except in holding the track to gage, which fact seems to be recognized by the management, as it is proposed that some of the track shall be laid with ties spaced at 10-ft. centers.



STREET RAILWAYS LAID IN CONCRETE

"The sections show that the concrete comes against the flat base of the rail, the outline of the excavation being such as to

bring the thickness of the foundation to a depth of 6 in. below every part of the rail and the tie. This applies also to the curved ties used on Gratiot avenue. Upon the top of the concrete a ½-in. sand bed is spread, which is surmounted by Canton pavers to be flush with the top of the rail. This pavement covers the space between the rails only, the paving of the remainder of the street being asphalt. The track on Jefferson avenue has electrically-welded joints, which constitutes an experiment the success of which will depend upon the ability of the contractors to dress down the joints to a smooth surface after the weld is made. A new feature in this welding consists of compressing the rails by hydraulic power before welding. The greatest troubles anticipated from the welded joints are the rough joints and the danger of breaking in winter. It is expected, however, that the compression method will overcome the breaking. The track in Detroit which has been laid in concrete is reported to be giving indications of success in every direction." As to the application of concrete to roads with higher requirements as to load carried, etc., the editorial quotes the views of a prominent steam railway engineer who has followed this track construction very closely. "There is no question about track laid on concrete being the proper thing for city streets. I believe that it is among the possibilities that track on concrete is the proper thing for steam roads. Its first cost would be somewhat more expensive than track laid on dirt or stone ballast, but I believe the maintenance expenses would be reduced sufficiently to more than offset the increased cost. Of course, such track for steam roads would be impracticable, unless the mills furnish straight rails. They have been a long way from doing this in the past, but have been making great improvements recently."

Managing Fuel and Water Supplies.

A VERY desirable feature is developing in the organization of workingmen's societies,—that of giving to the world their experience in the shape of papers and addresses. The Traveling Engineers' Association affords a good illustration of this tendency. At a recent meeting held in Pittsburg, Pa., among other valuable contributions a committee report was read upon the question: "Could not the locomotive service of the country be improved if the furnishing of feed-water and coal was in the hands of the locomotive department?" The committee secured information from a variety of sources, and, according to *The Railway Review* (Sept. 14), ascertained that "on English lines the locomotive fuel supply is under the control of the locomotive superintendent. The colliery companies send in tenders for a particular quantity of coal, and every wagon-load they send is examined by an inspector on behalf of the locomotive superintendent. Some of the various qualities of coal are carefully tested, both in practice and by the experts in the testing department; there is, therefore, no fear of any person supplying bad coal to the companies." Continuing: "Your committee would recommend that, from whatever source coal is furnished, the mechanical department should be consulted with reference to the quality, it frequently happening that a much better grade of coal can be procured at a very slight advance in price; and it should also be consulted with reference to the assigning of certain kinds of coal to certain districts, with a view of adapting all draft appliances within such districts to suit the coal furnished. With reference to the water supply, there seems to be considerable tendency on the part of those answering the circular to place the boiler water supply in the hands of the locomotive department. . . . Your committee believes that, in furnishing feed-water to boilers, the interests of railroad companies could be best conserved by having the handling of same in the mechanical department, or, at least, the head of the mechanical department should be consulted with reference to the quality of water furnished, and, where water is not suitable, means should be at hand for its betterment. One of the great losses entailed by railroad companies is caused by the use of bad feed-water, not only to the deterioration

of the boilers, but also on account of loss of power, increased fuel consumption, and delay to traffic." The conclusion seems to be that, as the mechanical department designs, constructs, and repairs the locomotives, it should specify what fuel and water would produce the greatest result with the least wear.

THE RAILWAY GAZETTE for October says that the returns of gross earnings for the month of September, published last week by the *Chronicle*, show for 126 roads a gain of 4.57 per cent. over 1894. Certain unfavorable influences were acting during the month, among these a diminished cotton movement, a small wheat movement in the Central Western states, and, for railroads extending over a great area, thorough demoralization in rates. The spring wheat movement, however, has been very heavy, over 9 million bushels being delivered in Duluth in the four weeks as compared with a little over 4½ millions the year before. Almost 10 millions were delivered at Minneapolis as against about 8¼ millions the year before. The greatest increase in gross earnings is shown by the Great Northern, which amounts to over $417,000. Its September business was the largest in the history of the road. The Milwaukee & St. Paul shows an increase of about $273,000, and the New York Central $184,000.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Technical Journals—See Introductory.

1299. The Massachusetts Railroad Commission. William A. Crafts (Origin and growth of State supervision of railroads in the United States, exhibited chiefly by an account of the work of the Massachusetts commission). Eng Mag–Nov. 400 w.

*1329. Locomotives of the Great Eastern Railway, Past and Present. Ill. (Description with dimensions of locomotives used since 1845). Ry Wld–Sept. Serial. 1st part. 1200 w.

*1330. The Working Expenses of Electric and Cable Railways (A comparison, with 16 tabular statements, and items of expenses). Ry Wld–Sept. 1200 w.

*1331. Tramway Management (A rejoinder to "Tramway Manager" by a Tramway Official). Ry Wld–Sept. 1700 w.

1352. Comparative Merits of Metal Tie-Plates (Discussion by the makers, before the Northwest R. R. Club, of the comparative merits and faults of three forms of tie-plates. An excellent article). Eng News–Sept 12. 1900 w.

1357. Express Locomotives. John A. F. Aspinall (Part of a general paper read before the International Railway Congress. Interesting, broad and instructive). Eng News–Sept. 12. 4000 w.

1362. Some Underground Conduit Systems for Electric Roads. Ill. (A valuable summary of various devices which have been used). R R Gaz–Sept. 13. 2200 w.

1363. The Railroad Race from London to Aberdeen. J. Pearson Pattinson (A tabulated statement of time made between stations and also the world's record made by the West Coast route. Ill. of locomotives used). R R Gaz–Sept. 13. 1000 w.

1364. Some Weaknesses of State Railroad Management (Portion of a monograph on "Transportation" by R. van der Borght, with editorial). R R Gaz–Sept. 13. 1800 w.

1367. Continuous Rails on Steam Railroads. Walter Loring Webb (Considers it safe to use a rail 500 ft. long. Some interesting results of experiment and observation). R R Gaz–Sept. 13. 1600 w.

*1386. Street-Car Propulsion. W. A. Anthony (Considering the problem of obtaining a variable speed on the car from a constant-speed motor). Elec Eng, Lond–Sept. 6. 1500 w.

1390. Some Features of the Electric Power Plant of the Chicago City Railway Co. Ill. (Descriptive). Elec Ind–Sept. 1200 w.

*1411. A Year's Railway Accidents (Review of a Parliamentary paper showing that one passenger is killed in 7,789,000 journeys, and one in 789,000 is injured. The proportion of passengers injured in the United Kingdom was, in 1894 one in 2,626,000). Ry Times–Sept. 7. 1100 w.

1412. American and British Railways Compared (Giving tabulated statement comparing the various items of equipment, earnings and expenditure). Ry Age–Sept. 13. 400 w.

1436. The Madras Railway. Ill. Clement F. Street (Concise description of system, with nine half-tone illustrations of the shops, station, engines and cars. The gauge is 5 ft. 6 in. Includes specifications of locomotives used). Ry Rev–Sept. 14. 800 w.

1437. Prevention of Black Smoke from Locomotives (An answer to the question "How Can the Traveling Engineer Assist in Preventing the Unnecessary Emission of Black Smoke." Report of Committee). Ry Rev–Sept. 14. 1000 w.

1439. Lessons from the English Races (Editorial comment on the results of making rapid time on the English railroads). Ry Rev–Sept. 14. 1500 w.

1440. The Traveling Engineers' Association Reports (An abstract of ideas presented at the

We supply copies of these articles. See introductory.

meeting of the Traveling Engineers Association). Ry Rev-Sept. 14. 1200 w.

1441. Some Interesting Features of Interlocking. Ill. George H. Paine (An extended abstract of a paper read before the Engineers Club of Philadelphia in July). Ry Rev-Sept. 14. 2000 w.

1442. Best Methods of Managing Fuel and Water Supplies (Report of a Committee of the Traveling Eng. Asso. with reference to which department they should be under). Ry Rev-Sept. 14. 1600 w.

1445. The Gas Railway in Dessau. W. von Oechelhaeuser (Development of the Lührig System in Germany. A description with map and tables of costs and expenses. The motive power consists of seven and ten horse power gas-engines). Pro Age-Sept. 16. 6000 w.

*1451. Four-Wheeled Coupled Bogie Tank Engine. Ill. (Design for English passenger tank locomotive with complete dimensions and engraving of side elevation and inset drawing). Engng-Sept. 6. 500 w.

1460. Car Transfer Bridge at West Norfolk, Va., Atlantic and Danville R. R. Ill. (Detailed description of a hinged bridge for transferring railway cars from the pier to the barge or steamer). Eng News-Sept. 19. 1300 w.

1463. The Acceleration of the Speed of Express Trains (An editorial discussion of the probable effects of the recent railroad races in Great Britain and the American records lately made with the comparison of interesting data). Eng News-Sept. 19. 3800 w.

†1470. The British Railway to India (Editorial criticism upon a proposed railway through Persia). Ind Engng-Aug. 24. 1600 w.

1492. Position Signals for Night Use. J. W. Lattig (A device for intermittent lighting of railway signals). R R Gaz-Sept. 20. 1000 w.

1493. Tests on Cylinder Condensation of the Baldwin Compound Locomotive at Purdue University. Ill. R R Gaz-Sept. 20. 1400 w.

1496. Ventilation of Passenger Cars in Summer (Editorial comment upon inconvenience arising from open car windows at inappropriate times, with suggestions for improvements). R R Gaz-Sept. 20. 1700 w.

1497. Fast Time in England and America (Editorial. Comparison of time made by recent runs on English and American railroads). R R Gaz-Sept. 20. 1300 w.

1498. Care and Maintenance of Telegraph Lines (Editorial comment on railroad telegraph lines). R R Gaz-Sept. 20. 1200 w.

1499 The Greatest of Railway Runs—436½ miles in 407 minutes (A graphic description from *N. Y. Sun* with time made). Ry Age-Sept. 20. 2500 w.

1500. Notable Meeting of the Western Railway Club (Remarks upon the International Railway Congress by Colonel Haines, and response to a toast. The passenger department by Mr. Heafford). Ry Age-Sept. 20. 4000 w.

*1507. Railway Accidents and the Lessons They Teach (Editorial comment on the report of the Board of Trade, giving statistics). Trans-Sept. 13. 1500 w.

*1508. The Galway and Clifden Railway (General description of a projected West Ireland Railway. Map and four half-tone views of scenery). Engng-Sept. 13. Serial. 1st part. 2000 w.

*1523. The Snaefell Mountain Railway. Ill. (A pleasure line, interesting on account of the rapidity which has marked its construction, and because it is the first time electricity has been used in the British Isles on such heavy grades). Elec Rev, Lond-Sept. 13. 2800 w.

1528.—$1. The Substitution of Electricity for Steam in Railway Practice. Louis Duncan (A consideration of electric traction as it stands at present. Discussion). Tr Am Inst of Elec Eng-June & July. 10000 w.

1543. New Car Shops at Burnside—Illinois Central Railroad. Ill. (Description of these shops, twelve miles from Chicago, with map, plans and detail cuts). Ry Rev-Sept. 21. 2500 w.

1545. Filling with Sluiced Material. Ill. (The filling in of trestle bridges on the N. P. R. R. making permanent embankments). Ry Rev-Sept. 21. 600 w.

1554. Montreal Street Railways. Ill. (Descriptive). Elec Ry Gaz-Sept. 14. 2300 w.

*1558. The Isle of Man Electric Tramways. Ill. (Snaefell electric tramway. Description. The Douglas-Loxey). Elect'n-Sept. 13. 4000 w.

*1561. The Subject of Light Railways as an Assistance to Agriculture. C. E. Webber (Paper read in Section G of Brit. Asso. at Ipswich). Elec Eng, Lond-Sept. 13. 8000 w.

1569. How Shall We Heat Cars? J. F. McElroy (Abstract of a paper read before the St. Ry. Asso. of the State of N. Y. General principles involved in the construction and operation of electric heaters, etc). Elec Eng-Sept. 25. 2300 w.

1573. General Track Construction. C. Loomis Allen (Read at N. Y. State St. Ry. Con. A progressive description of the best methods in use). Elec Ry Gaz-Sept. 21. 2000 w.

1597. Freight and Mail Traffic on Street Railways. Benjamin Norton (Interesting details showing how it is made to pay). Eng News-Sept. 26. 1100 w.

*1598. Operating an Electric Road on a 25½% Grade. Ill. (An endless cable device, the ascending and descending cars balancing each other, with four cuts of designs and details). St Ry Rev-Sept. 15. 2000 w.

*1600. Dey-Griswold Hydraulic Gear. Ill. (The substitution of oil under pressure from pumps with variable stroke, acting on motors, for gears). St Ry Rev-Sept. 15. 600 w.

1616. Railroading Over an Earthquake. Ill. Cy. Warman (An American engine-driver's strange experience on an engine in Europe). McClure's Mag-Oct. 2500 w.

1617. The Traveling Engineers' Association (An abstract of the proceedings with a lengthy article on air-braking). R R Gaz-Sept. 27. 4000 w.

We supply copies of these articles. See introductory.

1618. Standard "Front End" of Car Adopted by the New Haven Railroad Ill. (Short reference with two sections illustrating the construction). R R Gaz-Sept. 27. 200 w.

1622. Passenger Station of the Eastern Railroad at Paris, France. Ill. (Description with map showing system of tracks). R R Gaz-Sept. 27. 700 w.

*1642. The Railways of the United Kingdom (An editorial on the financial condition of English Railways). Trans-Sept. 20. 2800 w.

*1643. Breaking the Train Speed Record. Ill. A. S. (Description of trip on the N. Y. C. & H. R. R. on the occasion of making the world's record). Loc Engng-Oct. 2500 w.

*1644. More Facts About the British Train Racing. Ill. (Details of the recent British fast runs, with six half-tone illustrations of the types of racing engines). Loc Engng-Oct. 1100 w.

*1645. Six-wheeled Truck. Ill. (Details with drawings of truck used on the B. & O. R. R.) Loc Engng-Oct. 600 w.

*1646. Strengthening of Ends of Passenger-Train Cars (Drawings with description of some new designs by the B. & O. R. R). Loc Engng-Oct. 1200 w.

*1647. Railway Capital, Revenue, and Traffic, 1894 (Abstracts from the Board of Trade return on English railways). Ry Times-Sept. 21. 7800 w.

1652. A New Conduit Railway System. Ill. (A system which possesses several points of novelty. The invention of John La Burt). Elec Ry Gaz-Sept. 28. 700 w.

*1659. A Large Railway Ferry Steamer. Ill. (A boat conveying cars across the Volga. Length 252 ft., carrying 24 trucks). Eng, Lond-Sept. 20. 1200 w.

*1660. Express Locomotive, North-Eastern Railway. Ill. (Showing relation between track and stack draught and arrangement of exhaust used). Eng, Lond-Sept. 20. 400 w.

1672. A Melan Arch Railway Bridge. Ill. (Details of a re-enforced concrete arch, eight track bridge). Eng Rec-Sept. 28. 900 w.

1695. Street Railway Tracks Laid in Concrete. Ill. (An excellent system of track construction with steel ties 5 ft. apart, supporting 100 lb. rails, all embedded in concrete and topped by Canton pavers). Ry Rev-Sept. 28. 500 w.

1696. The Glasgow District Subway. Ill. Angus Matheson Stewart (Sections of tunnel for an underground passenger railway 6½ miles long, containing two tracks, operated by cable). Ry Rev-Sept. 28. 2800 w.

1697. Fast Freight Lines and Their Evils (Editorial advocating discontinuance of through freights). Ry Rev-Sept. 28. 900 w.

*1708. A Narrow Gauge Electric Locomotive. Ill. R. W. Weekes (Built by Easton, Anderson and Golden for the 18 in. line between the electrical school at St. Mary's Barracks, Chatham, through the dockyard, into the submarine mining establishment at Gillingham. Descriptive). Elec Eng, Lond-Sept. 20. 1800 w.

†1741. Consular Report on the Tramway System of Paris and the Department of the Seine, France (An exhaustive report, giving the history, decrees, concessions, etc. in the development of this French railway system). Ind & East Eng-Aug. 31. Serial. 1st part. 1800 w.

†1758. The Electric Railway System of Niagara Falls. Ill. (Description of the power plant, equipment, construction and operation of several electric car lines in and about Niagara Falls). St Ry Jour-Oct. 6800 w.

†1759. Some Notes on the Manufacture of Car Wheels (A treatise on the effect of chilling upon cast iron wheels, with three half-tone illustrations of effects shown by fractures). St Ry Jour-Oct. 2000 w.

*1760. Lead for Locomotives. C. A. Seley (Discussing the effect of too much lead as shown in railroad locomotive practice. Illustrated by indicator cards). Nat Car & Loc Build-Oct. 2000 w.

1780. Combined Motor and Baggage Car for Suburban Roads. Ill. (Description of cars used on the Nantasket branch and other electrical roads). W Elec-Oct. 5. 800 w.

1790. The Comparative Efficiency of Track-bolt Nut Locks (The results of tests on 14 kinds of nut locks, with diagram). Eng News-Oct. 3. 500 w.

1791. Railway Track and Maintenance (Abstracts of committee reports presented at the meeting of the New England Road-master's Asso., on tools, spikes, bolts, braces, tie-plates, &c., with recommendations). Eng News-Oct. 3. 1400 w.

1800. The Need of Care in Selecting the Source of Water Supply for Locomotives (Extract from a letter to the Traveling Engineers Asso. Suggestions worthy the consideration of roads that have done little to improve their water supply). Ry Mas Mech-Oct. 900 w.

1801. Compound Locomotive Test on C. & N. W. Ry. Storm Bull (From a paper read before the W. Ry. Club. Tests conducted and thesis written by Messrs. Hartwell, Hansom and Meyer, seniors in mechanical engineering at the Univ. of Wis). Ry Mas Mech-Oct. 2000 w.

*1833. Brake Trials on the North-Eastern Railway (Description of tests with diagrams representing results on a Westinghouse quick acting brake, relative to its application to ordinary brakes now in service). Eng, Lond-Sept. 27. 3000 w.

1844. The South Orange and Maplewood Railway. Ill. (The notable features of the work are the solid construction of the road and the excellence of the material used. Every effort has been made to make the road as nearly perfect as possible. Descriptive with notice of interesting features). Elec Ry Gaz-Oct. 5. 1000 w.

1860. The proposed Jungfrau Electric Railroad. Ill. V. M. Berthold (A short abstract from the latest available information. The road when finished will be the highest railroad of the world). Elec Rev-Oct. 9. 1000 w.

SCIENTIFIC MISCELLANY

Fighting Forest Fires.

A WRITER in *The Forester* for September says that a potent reason for forest fires, such as occurred in the vicinity of Shemong and Reed's crossing in July, 1894, is the want of any special organization for preventing and combatting them. When these fires approach and threaten the homes of residents, the people imperilled will make efforts to turn the course of the conflagration for self-protection; otherwise, the fires go on till they burn themselves out or are extinguished by an opportune rainfall.

The writer gives a very interesting narrative of the forest fire above mentioned, and of the feeble, disconnected efforts that were made to arrest its progress. "The fire was very disastrous." The author of the article, Mr. Price of Tuckerton, "was an active participant in its extinguishment." It extended over an area of 175,000 acres, converting the tract burned over into a veritable desert. Though its origin was 20 miles away from Tuckerton, it seriously threatened Tuckerton before it ended. But, passing further details of the progress of the fire, we will let Mr. Price tell the story of the efforts put forth to save Tuckerton.

"On the Friday the fire raged across the country I rode out into the woods to investigate. The main body of flames had swept by upon Stafford Forge and Manahawken, but the long flank was left,—mile after mile of fire backing down toward Tuckerton. A northwest wind would, therefore, bring us instant and most alarming peril. An attempt was made to rally a fighting force, a harnessed team going at evening into the village, and the danger and opportunity being both presented. The men acknowledged the truth of all that was said, but firmly took the stand that they ought to be paid.

"Are they not right? They do not own a foot of forest. The owners are capitalists living in New York, Philadelphia, and other States and cities. Why should boatmen and laborers spend a night in severe and dangerous toil without compensation, fighting for absent owners? And again: why should absent owners pay men to fight fire when they go out in an undisciplined mob, under impromptu leadership, and when it is often too late to save the property? And again: who shall telegraph the owners and get them to act?

"If any one thinks townships can act, I reply, this fire burned property in at least eight townships. For them to act as townships would be a wasteful and confusing policy. If the State acts by means of large districts, we shall have unity. This fire could have been put out a dozen times by a small State force, paid, officered, disciplined, and known to have authority. The State taxes forest property and also the exposed towns. Does it not owe them protection? One cent per acre annually, under wise organizations, ought to pay the cost.

"But Tuckerton was not rid of her fire. Nature has encompassed her with bays and rivers, and a merciful Providence held the wind continuously in a quarter from the sea. Still the fire slowly enclosed her. Alive to the folly of sitting still, another effort was determined upon. Knowing two good men who were willing to fight, it was decided to go out with these alone, if necessary, but there were hopes that the example would have inspiration. So it proved. We started one evening at 6 o'clock, and by 9 had fifteen or twenty men. Three or four miles of fire were subdued, and, when we returned, wearied, at 3 o'clock in the morning, it was expected a fresh force would finish the arduous battle. But the fresh crew never came, and the mile of fire left burning 48 hours undid the work accomplished.

"Another proof of the need of the organization. Other days pass, and again one afternoon the smoke arises black and near. I hasten forth to find a Jew in the

outskirts has been seized with a panic, and has set a fire nearer, hotter, and more dangerous than the one that frightened him. The new fire sweeps wildly before the wind, whereas the old fire had to burn against the wind. Fifty men sit looking on. Two things are evident. One is that nineteen-twentieths of the people are mere spectators. The other is that a section gang sent by the railroad, being paid for their time, expect to work. These men go into the line of fire, but the task before us is hopeless unless we can find a strategic point from which to fight. Fortunately it is found at last, just in the nick of time, and by hard work and back-firing we gain the day.

"This fire, so narrowly brought under control, ought to have been watched, but, with no system, who is to do the watching?

"In a few days there is peril again, with the enemy at still closer quarters. Two bodies of men go out and begin work by direct assault on each extremity of the fire. They are perhaps a mile apart. The thermometer in the woods is above 100 deg., and the flames are like a furnace. The men lie down again and again from exhaustion. There is no drinking water. The woods are a tangled thicket of undergrowth and briars. No tidings come from one company of men to the other. No one knows whether the fight is maintained elsewhere, or how large a body of fire remains to conquer. Discouragement appears. Then a volunteer on one company undertakes to determine the situation. He finds two-thirds of the fire put out; the other company of men completely discouraged and on their way home; a plucky worker fighting single-handed in the middle of the line of fire, though ignorant of other helpers.

"A knowledge of the situation cheers every one, and all return to work with a will. Drinking water is brought by a team, and in a brief space the battle is over. Many lessons appear, but they sum up in this: there must be organization, and it is especially desirable to have good leadership. Everybody's business is nobody's business."

Anomalies in Sanitation.

THE basis upon which the whole structure of sanitary engineering rests is the proposition that zymotic diseases can be prevented. If this proposition be broadly true, the reason for the existence of sanitary rules and appliances, and for knowledge and skill in their application, is obvious; if not true, the belief (expressed by some) that much of what is taught and insisted upon by sanitarians is humbug, and much which is done by sanitary engineers is an expensive concession to pseudo-science, is well-founded. Those who entertain this belief are wont to clinch their arguments with the question: "if disease can be prevented, why, notwithstanding the adoption of all these rules and appliances, does not the class of diseases to the prevention of which they are specially framed and directed disappear from civilized communities?" This question *The Sanitary Record* (Sept. 6) meets with a complete answer, which is that "both individuals and communities still continue to preach without practising the things which are now generally admitted to be essential to healthy life." As one example of the truth of this statement the following is quoted:

"Only recently it was the writer's pleasure and privilege to spend a portion of his holidays in the Hartz mountains,—the Oberland of Germany, in the province of Brunswick, where Dame Nature has been profusely generous in her distribution of beauty. The district, while comparatively unknown to, and far from the beaten track of, the British tourists, is, by reason of its being the only part of Northern Germany deserving of the name of mountainous, dearly beloved by the denizens of 'Vaterland'; and hither a yearly increasing flock of them wend their way, doubtless with benefit to nearly every one concerned. Provision in abundance for this annual influx is to be found in the way of conveyance and of accommodation, the hotels, pensions, gasthauss, and cafés vieing with each other in their amplitude of attraction and comfort. So far, so good, and, to the mind of the Guelph, an earthly paradise.

"Midst of all this wealth of natural

beauty and catering for popular patronage, and in a country so deservedly famed for its research, investigation, and discoveries in the deeper realms of the science of hygiene and sanitation, it might reasonably be expected that some little attention would here be paid to the ascertained elements of those subjects, but what a rude awakening the assumption receives!

"Down as pretty a valley as the eye could see or the mind can conceive, there winds its way through a charming village a mountain streamlet, innocent at its rise of the near presence of a civilized community. As we approach it and the village from the lower side, an odor more pronounced than pleasant is perceived, and a friend suggests the proximity of a pig cote. A second thinks it probable that a middenstead is being disturbed, while a third makes a deviation, and solves the query by finding a sewage-bearing brook, which, on further investigation, proves to be at once the sewer for the district and a continuation of the aforesaid virgin streamlet?

"It would probably be argued by those who are responsible for such a condition of affairs, should there be any such, that, if it is a danger at all, its potency for evil is reduced to a minimum by the open nature of its surroundings, and that the volume of pure spring water which is constantly flowing through the channel suffices for all practical purposes to keep it clean and sweet. This, however, is an argument that has often been exploded; and to those who are cognizant of typhoid fever at Lausanne in Switzerland some years ago, when the calamitous, and at first incomprehensible, appearance of the disease was ultimately traced to the pollution by sewage of the village stream some 2 or 3 miles from the site of the outbreak, the contention would, if advanced, be rejected with scorn."

The internal arrangement of sanitary appliances in the region named are also very objectionable, as was found on investigation, although external cleanliness appears to prevail to a marked degree; and these arrangements indicate a wide-spread ignorance of facts and principles.

Process for Preserving Fresh Fruit.

A PROCESS stated to be new by Mr. Henry P. du Bellet, United States consul at Rheims, is so simple that it appears worthy of a good trial. It has the merit, also, of cheapness. An account of this process is contained in *Consular Reports* for September.

Impressed with the powerful action of alcoholic vapors on the mold which generally appears on the surface of fruits in a damp atmosphere, Mr. Petit noticed that pears and apples kept for several months in a surrounding atmosphere saturated with vapors of water and alcohol, even were they at the beginning in a state of decay, showed no signs of mold, while fruits in every particular similar to the former, stored under the same conditions, but not exposed to the action of alcoholic vapors, were entirely covered with it.

Taking advantage of this observation, Mr. Petit applied the principle to the preservation of fruits in general, and most particularly to grapes, because more than others these are subject to mold. It was to be foreseen that grapes kept from the day they are cut off the vines in an atmosphere saturated with vapors of water and alcohol would, by the retarding of the sweating period, not only remain free from mold, but even retain their natural aspect. Consequently, should the temperature be constant and low, the preservation could be maintained long and well.

"On the 31st of October, 1894,—that is, very late in the season and at a very unfavorable time,—Mr. Petit placed, with other fruits, and a bottle containing 61 cu. in. of alcohol at 96°, some bunches of grapes known as 'Chasselas de Fontainebleau,' fresh from the vine, in a brick recipient in the form of a parallelopiped, cemented inside and closed as hermetically as possible by a common wooden door. In two similar recipients contiguous to the first, one of which was kept open and the other closed, but without alcohol, were stored similar fruits from the same trees and vines. The fruits were laid on wood shavings. The recipients were built in a very damp cellar, temperature of

which varied regularly from 50° to 46.4° F. during the whole time the experiment lasted.

"On November 20 the grapes placed in the recipient left open, and especially so those in the closed recipient without alcohol, were mostly rotten and covered with mold. In the recipient containing the bottle of alcohol the grapes were beautiful; on one bunch two grapes had turned brown, but they were firm, full, and free of mold; they did not taste at all sour, thus differing essentially from moldy grapes, especially those subject to *Penicillium glaucum*. A hair hygrometer in the recipient registered 98°. On December 7 the bunches of grapes in the recipient containing the alcohol had kept their fine aspect; on most of them, however, one or two grapes had turned brown, and were in the same condition as those above referred to. On December 24 same results; on most of the bunches could be seen one or two grapes commencing to decay. At the end of nearly 2 months each bunch had lost but from two to four grapes, and all were in a perfect state of preservation, the stalks being perfectly green and the grapes firm, full, and savory, and having all the qualities of fresh cut grapes.

"At the conclusion of the experiment, 17 cu. in. of alcohol at 60° remained in the bottle out of the 61 cu. in., but, as Mr. Petit remarks, the door of his recipient had not been built with great care and did not close hermetically; hence a useless consumption of alcohol."

"This process, if further trial prove its efficiency, offers many advantages. It is simple, easy of application, and cheap, and, if adopted by our fruit growers, would allow them not only to hold their fine fruits until they can dispose of them at a fair price, but would also insure them handsome profits during the winter months."

Industrial Value of Ramie Fiber.

FOR a long time the attention of manufacturers, scientific men, and inventors has been directed toward the utilization of the ramie fiber, and such progress has been made, notwithstanding mechanical difficulties in working it, that it now bids fair to figure extensively in the list of textile materials. The Boston *Journal of Commerce* (Sept. 14) gives, editorially, a pretty good showing of progress in the utilization of this fiber, and states some interesting facts.

The sails of the yacht Defender were of this material, the yarn, imported from England, having been woven into duck cloth at the mill of the Lowell Weaving Co. The superintendent of this company is reported to have said that "it is the best material ever used for duck," as it neither stretches or shrinks when subjected to moisture and is "30 per cent. stronger than Sea Island cotton. The sails of the Valkyrie were also of ramie duck."

Our contemporary announces that there is a new mill at Cranston, R. I., devoted to the manufacture of ramie, and thinks that in this mill the industry will be developed farther than hitherto, although the number and extent of the uses to which the fiber has been put already will be new to many people. "For goods usually made of linen, ramie is said to be particularly applicable on account of its great resistance, both with regard to washing and to wear. The most important hotels and railroad companies in France have, it is stated, entirely adopted the use of ramie, and it is also asserted that the city of Paris has adopted this linen for the service of its twenty arrondissements, and that it has been ordered for the dressing of wounds in several hospitals, including those for the army and navy. It is said that the minister of war employs it for the cordage of balloons, powder sacks, etc.; that the Bank of France now uses nothing else for the manufacture of its notes but the ramie supplied by the Valobre factory, and that it finds the new bank note of ramie to be finer, more durable, and capable of receiving a better impression, consequently rendering forgery of notes much more difficult, if not impossible.

"The possibilities of the ramie fiber in manufacture seem to be unlimited, such as its use in stuff goods for men's wear, upholstery, curtain laces and embroideries, plushes and velvets, stockings, under-

clothing, table damasks, napkins, handkerchiefs, shirtings, sheetings, sail ducks, carpets, cordage, fishing nets, and yarns and threads for various uses. The facility with which ramie may be made to imitate all other textiles is said to be one of the principal causes which has kept back the development of the industry, and it is thought that if, instead of launching out into a series of experiments, attention had been concentrated upon the exclusive manufacture of those articles to which the properties of the plant were peculiarly and naturally adapted, the industry would probably be in a more advanced condition than it is at present."

Some fine exhibits of ramie fiber, degummed by the Forbes process and by Jones and Warr, were shown at the late World's Fair in Chicago. Another process of degumming that has given excellent results is known as the "Boyle" process. The cultivation of ramie is, at present, as it has been in the past, engaging much attention in the United States agricultural department, with encouraging results. It is believed that it has a great future.

The Future Rubber Supply.

IT having been proposed about a quarter of a century ago to enter upon the artificial cultivation of plants and trees yielding caoutchouc in view of the supposed likelihood that the demand would outgrow the supply, and some attempts at such culture having been made, this "new departure in economic botany" is discussed in *Engineering* (Aug. 30), its results having been "satisfactory as far as the possibilities of growth are concerned," although the cultivation of rubber plants "has not yet entered into serious competition with the rubber supply from untended nature."

The tone of the American technical press, *Engineering* thinks, would seem to imply that, although it has been demonstrated that rubber plants of different species may be artificially cultivated, the effort has been misdirected, and the "time and trouble" devoted to it have been "expended needlessly." The reasons assigned for this opinion are, in brief, that, while the demand for rubber has constantly increased, the price has not materially varied, indicating that the supposition of a possible early dearth of rubber, entertained at the time the experiments in artificial culture were initiated, was erroneous.

The experiments made are, notwithstanding, justified on the grounds that, at the date mentioned, there was a strong probability that a demand increasing more rapidly than the supply would enhance the price, and that many now known sources of supply were at that date unknown to the world.

"The common facts of to-day were not the common facts of 10 or 20 years ago. . . . . The discovery of these rubber forests is of recent date, and it cannot, therefore, be pointed at as an overlooked factor in the original consideration of the matter. It will be remembered by those interested that the representations made to our Kew authorities as to the depletion of the rubber forests were couched in distinctly alarmist language, and therefore they quite merited the measures taken by the India office. Of course it was possible for our government to have undertaken such explorations as have recently been made by private individuals, and this would probably have resulted in the alarmist rumors being somewhat discounted, as we may presume that the forests of to-day existed in much the same condition 20 or 30 years ago. However, it is easy to be wise after the event, and we shall certainly not be found in the ranks of those who seek to throw ridicule on the whole movement, because, whether the expense and trouble which our Kew authorities have been put to seem warranted or not at the present time, it has certainly been shown that rubber trees can be successfully acclimatized and grown in India and other districts far remote from their original habitat, and occasion may yet arise when the information thus gained may prove of much value to the india-rubber industry."

Critical Temperature and Boiling Temperature of Hydrogen.

WHEN a gas, under sufficient pressure and cooled very nearly to the temperature

at which it will liquefy under that pressure, has its pressure slowly diminished, its performance of work through its own expansion during the reduction of pressure lowers its temperature to the liquefaction point, and, liquid forming throughout the mass, a temporary turbidity indicates the fact. The pressure at which this phenomenon takes place is called the "critical pressure." The temperature at which it occurs is call the "critical temperature," the phenomenon of liquefaction under the conditions named being in the nature of a crisis.

Upon this principle Professor K. Oloszewski, of the University of Cracow, founded his method of determining the critical pressures of gases. He now has communicated to *The Engineering and Mining Journal* (Sept. 21) an account of the method (which he calls "the method of expansion") of the determination of the critical and boiling temperatures, the critical temperature being that at which the above-mentioned turbidity occurs, and the boiling temperature being that at which the liquefied gas assumes the gaseous form again, under reduction of pressure. Applying this extension of the method to the determination of these data for hydrogen, he finds its critical temperature to be —234.5° C., and its boiling temperature to be —243.5° C., the difference being 9° C. That is to say, the temperature it assumes while changing its state from liquid to gaseous is 9° lower than that at which it begins to liquefy enough to show turbidity.

The paper is of great scientific and practical interest. It is on the alternate assumption of the liquid and gaseous forms by gases that the action of most modern ice-machines depends, and this class of machines is among the most notable engineering triumphs of the present century. The paper is too abstruse for the non-technical reader, but will be exceedingly interesting and instructive to scientists and engineers. The determination of these low temperatures is made by the use of platinum thermometers. As these are unfamiliar to most readers, it is proper to explain that they are instruments which give inferential indications of temperature through the variations of electrical resistance at different temperatures in a standard platinum conductor. A description of both apparatus and method is comprised in Prof. Oloszewski's communication.

Professor Natanson has confirmed the validity of Professor Olszewski's experiments and results by showing that they correspond with conclusions reached by thermodynamic methods.

THE pearl shell fishery, in West Australia, produces, annually, shell to the value of $500,000 to say nothing of the pearls gathered in addition. Large sums are expended on the pearling fleet and in keeping up the stations. Over one thousand men are employed in the trade. The artificial cultivation of the pearl shell oyster is now being essayed, but it is yet too early to determine with what results. Nearly all of the produce of the industry goes to England. Before shipment the shell is taken to one of the shore stations, weighed, packed, and is then placed on board.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Technical Journals—See Introductory.

1311. Cost of Steam and Water Power in Montana M. S. Parker (The author bases his comparisons of cost upon data collected during five years attention to the subject, and presents results in tabulated form, in a paper read before the Montana Soc. of Civ. Eng. He finds the available water power of Montana enormous). W Min Wld-Sept. 7. 1200 w.

1335. Long Range Rifle Practice. A. G. Holcombe (Description of targets, with horizontal and vertical lines to measure accurately the range and wind gauge). Sci Am Sup-Sept. 14 1000 w.

*1348. Color Influence (The effect of color in mural decoration, etc., upon the nervous system of occupants of rooms so decorated. Some curious instances related). Plumb & Dec-Sept. 2. 1200 w.

1373. The Roman Frontier System. Prof. Pelham (History and leading features). Arch & Build-Sept. 14. 3500 w.

1410. Ramie and the Defender's Suit of

We supply copies of these articles. See introductory.

Sails (Editorial. The industrial possibilities of ramie fiber. An interesting article). Bos Jour of Com-Sept. 14. 1000 w.

*1414. Anomalies in Sanitation (Editorial. Sins of omission and commission. Examples). San Rec-Sept. 6. 1000 w.

*1426. The United States Naval Proving Ground at Indian Head (A description of the testing ground and appliances used in the trials of guns, armor, projectiles and explosives purchased by the United States government). Eng, Lond-Sept. 6. 4000 w.

1457. Georgia Marble (The extent of the deposit, its characteristics and value). Tradesman-Sept. 15. 1100 w.

*1487. Address to the Mechanical Science Section delivered by Mr. L. F. Vernon Harcourt, President of the Section (Discusses the relation of engineering to science. Mathematics, physics, chemistry, geology and meteorology in relation to engineering; failures of works due to neglect of scientific considerations; engineering specification, etc.). Eng, Lond-Sept. 13. 7000 w.

1488 The Exploration of the Surface of the Globe. J. Logan Lobley, in *Knowledge* (Takes the ground that the field for geographical exploration is yet wide, and points out where such exploration may be profitably directed). Sci Am Sup-Sept. 21. 1600 w.

1494 The Exhibition at Atlanta. Ill. (General description and comments). R R Gaz-Sept. 20. 3800 w.

1501. Determination of the Critical and the Boiling Temperature of Hydrogen K. Olszewski (An application of the "expansion method" of determining the critical pressure of gases devised by the author, to the particular gas, hydrogen, for determination of the data named. Apparatus and method described. The critical temperature is thus fixed at—234.5,and—243.5 as the boiling temperature). Eng & Min Jour-Sept. 21. 2500 w.

*1542 The Rare Earths Used in the Mantles for Incandescent Lighting (Treats chiefly of thorium, its sources, and the character of minerals containing it, with hints for the commercial valuation of thorium nitrate). Jour Gas Lgt-Sept. 10. 2400 w.

*1548. Development of Carriages on Common Roads John Philipson (Presidential address to the British Inst. of Carriage Manufacturers. A retrospect of progress in road vehicles, including two centuries). , Prac Eng-Sept. 13. 3200 w.

*1570. The Relation of Science to Industry. N. S. Shaler (Consideration of the preparation which should be given to youths in order to make them fit to do their part in the industrial life of the time). Chau-Oct. Series. 1st paper. 3800 w.

1580. New Process for Keeping Fruit Fresh. Henry P. du Bellet (The fruits are kept in a moist atmosphere impregnated with alcohol vapor. Directions for carrying out the process are given and results stated). Consular Rep-Sept. 1000 w.

1581. A New German Lamp. Charles de Kay (A lamp wherein a chemically changed alcoholic spirit, volatilizing at low temperature, is burned, and an incandescent mantle gives the light). Consular Rep-Sept. 600 w.

1625. Facts about Trichina Spiralis, the Pork Parasite. Ill. (Facts and figures obtained at government inspection stations at Chicago, Milwaukee, Omaha, Kansas City and Boston during four years experience of the author in charge of the work. A valuable monograph). Sci Am Sup-Sept. 28. 1800 w.

*1639. Well-Meant but Futile Endowments: The Remedy. Charles F. Thwing (A review of endowments to colleges, universities, charities, etc., setting forth some of the causes that retard the good work intended, and drawing conclusions. The author thinks it undoubted that the cause of higher education represents the best object for the bestowal of general benevolence). Forum-Oct. 1400 w.

*1641. Higher Pay and a Better Training for Teachers. Jno. Gilmer Speed (An alleged deficiency in the qualifications of teachers for our public schools is attributed to want of a real appreciation of the value of education on the part of the American public; to want of proper qualification on the part of school trustees and members of boards of education, who employ the teachers; and, more than all, to the small remuneration of teachers for their services, which fails to attract the best talent into the profession of teaching. The remedy is suggested in the title). Forum-Oct. 4000 w.

*1683. A New Smokeless Powder (Editorial discussion of the remarkable properties of the Maxim-Schupphaus gunpowder, describing its composition and form; the effect upon projectiles being largely due to this form). Engng-Sept. 20. 1600 w.

*1684. An Improved Portable Photometer. Ill. W. H. Preece and A. P. Trotter (Paper read before section G, of Brit. Asso. A new photometer in which the Bunsen screen is replaced by a pierced diaphragm of white cardboard, and which comprises other innovations also). Engng-Sept. 20. 2500 w.

†1693. An Account of the Gardiner Lyceum, the First Trade School Established in the United States. John H. Cooper (This school was incorporated by an act passed Jan. 30, 1822. It is believed to be the very first school in the nature of a trade school ever founded in the United States. The account of this school is compiled from printed and written records possessed by George M. Holmes, of Gardiner, Me). Jour Fr Inst-Oct. 6000 w.

*1699. Production of Graphite from Carbon. Ill. (Describes the artificial production of graphite in the electric furnace with details. A very interesting, scientific article). Ind & Ir-Sept. 20. 2000 w.

†1725. Birds in Flight and the Flying Machine. Hiram S. Maxim (A study of bird motions, with brief reference to experiments made with flying machines). N Am Rev-Oct. 2800 w.

1750. Some High Mountain Observatories. Ill. Edward Whymper (Popular description of

high altitude observatories in Europe and America. A very interesting paper. Reprinted from *Leisure Hour*). Sci Am Sup-Oct. 5. 6000 w.

†1751. Trout Culture. Ill. Fred Mather (A well illustrated, practical treatise giving details necessary to success and noting causes of failure). Pop Sci M-Oct. 4800 w.

1753.—$1.50. The Temperature of Lakes. Desmond FitzGerald, with Discussion (An account of an important series of very difficult observations of temperature of lake-water at different depths, the interesting results of which are indicated graphically and also in tabulated form). Trans Am Soc of Civ Eng-Aug. 6500 w.

*1755. London by Night (Interesting popular description of the illumination of London in different parts of the city, which like the play of Hamlet with Hamlet left out, makes little or no mention of electric lighting, of which London certainly has some). Jour Gas Lgt-Sept. 24. 2000 w.

*1767. Trade Catalogues (Editorial. Treats of the shortcomings of this class of literature and seeks for a cause, which it finds in the lack of what Herbert Spencer calls constructive imagination and power of expression). Am Eng & R R Jour-Oct. 1500 w.

*1769. Aeroplane Stability During Flight. Ill. William Kress (Treats first of mechanical flight in calm air, and second, of a method by which an æroplane can be maintained in equilibrium during gusts of wind. A well written and learned dissertation. Describes also experiments made by the author). Am Eng & R R Jour-Oct. 4000 w.

*1811. Principles of Invention. Edward P. Thompson (Reversal in invention considered, and the importance of its systematic application to all inventions emphasized). Elec Pow-Oct. 3000 w.

*1814. Commercial Fibres. D. Morris (This first of the series of Cantor lectures the extent of commerce in fibres; essential element in fibres, fibre bundles, and cells; raw fibrous materials; botanical and chemical investigations of seed hairs; cotton; kapok and vegetable silks, leaving the discussion of latter topic to be completed in future lecture). Jour Soc of Arts-Sept. 27. 6000 w.

*1815. Cedar and Cork Forests of Algeria (Review of two brochures issued by the Algerian government for the purpose of drawing attention to the forests of the colony). Jour Soc of Arts-Sept. 27. 1200 w.

1816. Making Postage Stamps. How the Work is done in the Bureau of Engraving and Printing (Copied from the *Baltimore American*. An interesting, popular description of the business and processes of making U. S. postage stamps). Bos Jour of Com-Oct. 5. 1500 w.

*1818 The Superiority of Winter Wheat Flours. William Welsh (a paper read at the Penna. Miller's State Asso. An argument to prove that while spring wheat flour makes more loaves for a given weight than winter wheat, the latter makes better bread). Am Miller-Oct. 1. 1400 w.

*1821. The Visibility of Change in the Moon H. G. Wells (The author tries to show that there is ground for denying that the moon is indeed an immutable dead world beyond change). Knowledge-Oct. 1300 w.

*1822. The Voyage of H. M. S. "Challenger" and Its Achievements. H. N. Dickson (A brief account of the scientific researches of an expedition sent out in 1872 to examine the sea from surface to bottom). Knowledge-Oct. 3000 w.

*1841. On the Constituents of the Gas in Cleveite. C. Runge and F. Paschen (The gas believed to consist of two, and not more than two, constituents. One helium, the other ought to receive a new name. Conclusion confirmed by experiment). Nature-Sept. 26. 2200 w.

†1850. The Elective System as Adopted in the Michigan Mining School. M. E. Wadsworth (Describes the working of this system, introduced by Pres. Wayland of Brown University, and developed by Pres. Eliot, of Harvard, in the school named; predicting its ultimate adoption in all engineering schools). Am Geol-Oct. 2000 w.

1852. Tile Making in the Netherlands. Gustav Benfey (An interesting popular description of the details of the industry illustrated. First number treats of tempering and mixing). Brick-Oct. Serial. 1st part. 1400 w.

†1863. "Apergy": Power Without Cost. Charles Morris (A statement of the results of an investigation of the Keely motor, and an account of a visit to the workshop. Mr Keely claims to have successfully handled the problem of drawing energy directly from the elements of nature). New Sci Rev-Oct. 5000 w.

†1864. The Past and Future of City Traction. F. Jarvis Patten (A review of the various systems now in use with the prophecy that in the near future the horseless vehicle will move silently along city streets—probably propelled by petroleum or gas engines). New Sci Rev-Oct. 3800 w.

1880. Agricultural Experiment Stations (Inviting attention to Bulletin No. 26, just issued, which gives a brief summary of the objects of these stations in the United States, and their work as now conducted). Gar & For-Oct. 9. 1200 w.

1882. Lighthouse, Buoy and Lightship Illumination. Ill. (Historical account of illuminants used. In the present day the majority of lighthouses depend upon kerosene oil. Interesting article dealing fully with the subject). Sci Am Sup-Oct. 12. 4500 w.

†1884. Importance of the Trade in Old Rubber Shoes (The trade in rubber scrap is now most thoroughly organized in the west and northwest. Reclaimed rubber not an adulterant. It is a cheaper product, equal to the crude for some purposes, and even better for others). Ind Rub Wld-Oct. 10. 1500 w.

†1885. Government Tests of Rubber Springs (Tabulated statements of tests as they were taken down at the Arsenal, Watertown, Mass., where the experiments took place). Ind Rub Wld-Oct. 10. 400 w.

BOOKS OF THE MONTH

A TEXT-BOOK OF STATICS. By WILLIAM BRIGGS, M. A., LL. B., R. A. S., general editor of the University Tutorial Series, principal of University Correspondence College, and G. H. Bryan, M. A., Smith's Prizeman, fellow of St. Peter's College, Cambridge. New York: W. B. Clive, 1895 [220 pp., 7″×4¼″. Price, 40c.]

AN elementary course of statics is here supplied, which excludes those facts of the science requiring a knowledge of trigonometry on the part of the student. An effort has been made to lessen the difficulties usually encountered by beginners, here foreseen by the authors, who are experienced instructors in statics and dynamics. This purpose is accomplished by hints and explanations, which, without removing the necessity of mental effort, direct the pupil's mind, unconsciously to himself, toward the intellectual point of compass where lies the truth he seeks. One of the best features of the book is the profusion of examples to be worked out. The solving of such examples will impress the principles of statics upon the memory more than any other exercise. The examples are framed with a skill that can come only by experience in teaching.

THE ELEMENTARY PRINCIPLES OF MECHANICS. By A. Jay Du Bois, C. E., Ph. D., professor of civil engineering in the Sheffield Scientific School of Yale University; author of "Elements of Graphical Statics," "The Strains in Framed Structures," etc. Volume I, Kinematics. Volume II, Statics. New York: John Wiley & Sons, 1894. [Volume I, 231 pp., 6″×9″. Price $. Volume II, 392 pp., 6″×9″, cloth. Price, $4 00.]

THE same perspicuous style and judicious method that have characterized the author's previous admirable treatises are at once perceived in these books. Professor Du Bois stands in the front rank of American text-book writers, and the subjects he treats are presented with a skill matured by experience in teaching, and a knowledge of the easiest and best approaches to difficulties. The books are well printed and bound. Numerous practical examples for the application of principles are supplied; and in adapting these to the minds of students the author has displayed his skill as an instructor no less than in his accurate enunciation and clear explanations of physical laws. The books are entirely up to date, and in full accordance with the most recent accepted physical theories; they will, therefore, undoubtedly become authoritative reference books, as well as text-books for use in the classroom.

THE MODERN MACHINIST: A PRACTICAL TREATISE on Modern Machine-Shop Methods, describing in a comprehensive manner the most approved methods, processes, and appliances applied in present practice for cutting, shaping, fitting, erecting, and finishing metal work on the vise, forge, lathe, planing, shaping, slotting, milling, drilling, grinding, and other machines. By John T. Usher. Illustrated by 257 entirely new and original engravings made expressly for this work. New York: Norman W. Henley & Co., 1895 [322 pp., 5″×7½″, cloth. Price, $2.50.]

DIFFERING from others previously written and having a somewhat similar title, the treatise deals rather with improved methods and appliances for handling work on machine tools than with the construction of these tools, in which the author conceives that improvement has not been so marked as in modes of using them. From this starting-point the whole subject is discussed in a practical way by the author, who, from the character of the work before us, appears to have had an extensive experience in mechanical practice, and to have profited thereby to an extent which renders him competent to instruct others. The drawings are very largely in perspective, which is rather a unique feature in a work of this kind; they are line drawings with very little shading, and are carefully and clearly lettered, thus affording very ready reference to parts of machines mentioned in the text. The book is claimed to be thoroughly up to date.

A MANUAL OF MARINE ENGINEERING, COMPRISING the designing, construction, and working of marine machinery. By A. E. Seaton, lecturer on marine engineering to the Royal Naval College, Greenwich; member of the Institution of Civil Engineers; member of Council of the Institution of Naval Architects; member of the Institution of

Mechanical Engineers, etc. With numerous tables and illustrations reduced from working drawings. 12th edition, revised throughout and enlarged. London: Charles Griffin & Co., Ltd., Exeter street, Strand New York: D. Van Nostrand Co., 23 Murray and 27 Warren streets, 1895. [525 pp., 5½″ × 8⅜″. Price, $6 00]

THE remarkably favorable reception this book received when its first edition was published guaranteed that it would pass through many editions. Marine engineers have always regarded it as a standard authority. In this twelfth edition the revisions have brought it completely up to date. The modern innovations in marine engineering, such as torpedoes, tubular boilers, etc., are now incorporated in the scheme of the book, as are also appliances like feed-water heaters, evaporators, separators, and other new appliances for marine engineering service. In every respect that makes a good book this treatise cannot be too highly commended.

PROSPECTING FOR GOLD AND SILVER. By ARTHUR Lakes, late professor of Geology at the State School of Mines, Golden City, Colorado, author of "Geology of Colorado and Western Ore Deposits," "Geology of Colorado Coal Deposits," etc., Scranton, Pa: The Colliery Engineer Co. [207 pp., 5½″ × 7½″. Cloth. Price, $1.]

A COMBINATION of theory with practice in prospecting for minerals. Out of material contained in larger works have been culled such portions as are of immediate practical use to the prospector, and this information has been simplified and rearranged in a very skillful manner. The book is also based upon the personal experience of the author in the field, and of miners and prospectors comprised in his personal acquaintance. The valuable experience of members of the United States geological survey, with whom Mr. Lakes was at one time associated, has been made useful also. The limited number of minerals with which the prospector is likely to meet are very thoroughly described and pictured. The considerable variety of veins and ore occurrences are described and illustrated, the material for this purpose having been derived from occurrences in the principal mining camps in Colorado; and their geology, ore deposits, prospecting characteristics, etc., are given as the best examples and lessons of prospecting fields in the West. These examples are typical, and one who knows these camps thoroughly will be prepared for prospecting in almost any Western mining region. A valuable feature is contained in hints on the examination and reporting on mining properties, and the tricks, such as salting, etc., by which frauds are sometimes perpetrated. The book is of such size that it can be carried in the prospector's pocket, and is therefore very convenient for reference in the field.

ENGINEERING CONTRACTS AND SPECIFICATIONS, Including a Brief Synopsis of the Law of Contracts, and Illustrative Examples of the General and Technical classes of various kinds of Engineering Specifications. Designed for the use of students, engineers and contractors. By J. B. Johnson, C. E., Professor of Civil Engineering, Washington University, St. Louis, Mo. Member of the Institution of Civil Engineers; Member of the American Society of Civil Engineers; Member of the American Society of Mechanical Engineers, etc. 1st edition. Engineering News Publication Co. New York, 1895. [Cloth. 422 pp., 6″ × 9″. Price, $4.00.]

THE title gives a sufficient idea of the general character of this work. As specification writing is, in general, very imperfectly performed, and as imperfections of specifications give rise to much misunderstanding, and even to costly litigations, the information herein offered, relating to the law of contracts and specifications, together with the forms presented, will be a welcome aid to engineers and contractors in the preparation of this class of documents.

BULLETIN OF THE UNIVERSITY OF WISCONSIN, Engineering Series, Volume 1. No. 5. An Experimental Study of Field Methods which Insure to Stadia Measurements Greatly Increased Accuracy. By Leonard Sewal Smith, B. C. E., Instructor in Engineering. Published by Authority of Law, and with the Approval of the Regents of the University, Madison, Wisconsin. Published by the University, 1895. [145 + V pp.]

THIS is a valuable and important contribution to topographical and hydrographical methods, it being especially adapted for taking topography and hydrography, with or without the control of a triangulation, for meandering roads and rivers, and for making preliminary railroad surveys. That the method has also a much wider field of usefulness is indicated by the fact that a member of the American Society of Civil Engineers is at present sub-dividing forty thousand acres of Texas land into forty-acre tracts by the Stadia method.

NEW TRADE CATALOGUES.

Jeffrey Manufacturing Co., Columbus, O., U. S. A.=Catalogue, 16 pp., 9″ × 4″. [Describes and illustrates Jeffrey Patented Coal-Mining Machines, including drills, electric mine locomotive, elevating and conveying machinery, complete coal-mine equipments, coal handling machines, etc. A handsome publication.]

American Boiler Co., 94 Center Street, New York, U. S. A.=Pamphlet, 20 pp., 6″ × 9″. [Describes and illustrates the "Spence" hot-water heater for heating by hot-water circulation; contains also an essay on hot-water heating, such as is necessary for the information of purchasers, with table of dimensions and capacities, and a long list of references to purchasers who have the heater in use.]

New York Central Iron Works Co., Geneva, New York, U. S. A.=Pamphlet, 26 pp., 3¼″ × 6″, and 8 slips [each containing a testimonial letter, one of which is an autograph letter from an assistant quartermaster, U. S. A.-testifying to the satisfactory working of twenty-nine boilers used for house heating, officers-quarters, barracks, and other public buildings].

Charles D. Mosher, No. 1 Broadway, New York, U. S. A.=Pamphlet, 26 pp., 4″ × 6¾″, entitled "The Steam Separator, its Object, Action, and Application" [also containing a description of the Mosher Separator and enumeration of its uses, with illustrations and a table of dimensions, &c.]

C. W. Hunt Co., N. Y., U. S. A.=Catalogue No. 9506, "Coal Handling for Steam Generators," 52 pp., 6½″ × 9″. [Describes and illustrates the operation of handling coal and ashes in large plants, particularly in power stations, water works, on wharves, for railroad purposes, etc., etc. Very liberally and handsomely illustrated, and containing a large amount of information upon the subject.]

Interior Conduit and Insulation Co., New York, U. S. A.=Leaflet, 4 pp., 7″ × 8¼″. [Describes and illustrates the Lundell generators for gas-engine service.]

Walburn Swenson Co., Chicago, Ill., U. S. A.=Pamphlet, 8 pp., 7″ × 9½″. [Illustrates and describes the "Cotton Ginners' Compress" combining the cotton gin and compress in one machine, and contains testimonials from various authoritative sources as to the value of invention.]

W. D. Forbes & Co., Hoboken, N. J., U. S. A.=Catalogue, 19 pp., 6″ × 9″. [Illustrating and describing high-speed electric light engines, milling machines, revolution counters, hydraulic hand-pumps, etc.]

Proceedings of the Meetings of the American Railway Association held at the Planters' Hotel, St. Louis, Mo., April 17 and 18, 1895. [103 pp., 7]½p1×da″ co″

New Era Iron Works Co., Dayton, O., U. S. A.=Catalogue, 27 pp., 3½″×6″. [Describing the "New Era" engines for gas and gasoline.]

The Lane and Bodley Co., Cincinnati, O., U. S. A.=Catalogue, 74 pp., 6″×9″. [Describes and illustrates, with price list, the line of Columbian Corliss engines, with tables of performances and essay on first-class engine performance and feed-water heating; also directions for erection and adjustment of the engines.]

Hogan Boiler Co., Middletown, N. Y., U. S. A.=(1) Pamphlet, 8 pp., 7″×10″, "Proofs." [The discussion of advantages which the construction of the Hogan boiler is claimed to possess over all other boilers.] (2) Pamphlet, 1895, 9 pp., 7″×10″. "Truths and Proofs," [Adds to the foregoing a statement of operations of some of these boilers in use.]

The Ansonia Brass and Copper Co., New York, U. S. A.=Pamphlet, 36 pp., 4″×6″. [Describing the Tobin bronze, its physical and chemical properties, instructions for ordering, account of tensile strength, etc., and testimonials.]

National Lead Co., New York, U. S. A.=(1) Pamphlet, 16 pp., 5″ × 8″. "Concerning Babbitt or Anti-friction Metals." (2) Pamphlet, 29 pp., 5″× 8″. "Concerning Red Lead." (3) Pamphlet, 24 pp., 5″ × 8″. "Red Lead, and How to Use it." [The last-named pamphlet is an essay on the permanent protection of iron and steel, which, it is claimed, can be made certain by red lead, linseed oil, and proper application.]

International Permanent Exhibition Co., New York, U. S. A.=Pamphlet, 22 pp., 5⅜″ × 6¼″. [Containing prospectus of the company, which proposes to establish a permanent exhibit of the labor products of all nations at the Industrial Building, at 42d and 43d streets and Lexington avenue, New York city.]

The Carson Trench Machine Co., Charlestown, Boston, Mass., U. S. A.=Catalogue B, 34 pp., 9″ × 6″. [Descriptive of the Carson-Trainor hoisters and conveyors for excavating and refilling all kinds of trenches.]

The Cleveland Machine Screw Co., Cleveland, O., U. S. A.=Catalogue, 1895, 32 pp., 3¼″ × 5⅛″. [Descriptive of the New Process hardened steel balls. Describes, also, the process by which these balls are manufactured, with testimonials from those who have used them, and a list of purposes to which they can be applied.]

The Cleveland Machine Screw Co., Cleveland, O., U. S. A.=Illustrated catalogue, 31 pp., 7¾″ × 5¼″. [Describing automatic machinery for turning and finishing metal work of every description.]

The F. D. Cummer & Son Co., Cleveland, O., U. S. A.=Catalogue, 30 p., 9″ × 6″. [Describes and illustrates new and important features, both in principle and construction, distinctly new drying apparatus and methods, and different modifactions of furnace construction and system for supplying hot air to drying tunnels or rooms for the drying of brick, tile, pottery, and any other materials requiring moderate temperatures.